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A LINEAR PROGRAMMING MODEL FOR THE HAWAIIAN ISLANDS COMMERCIAL MULTIFISHERY

Laurel D. Kasaoka
Southwest Fisheries Center Honolulu Laboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

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PREFACE

This report was prepared under contract Number 40-JJNF-9-0189 to the Honolulu Laboratory of the National Marine Fisheries Service (NMFS). The work was supervised by Samuel G. Pooley, NMFS. Data and other background information needed for the project were obtained with the assistance of Kurt Kawamoto and Ray Clarke, NMFS.

The Lotus 1-2-3 spreadsheet used in this project is freely available, but the LP83 linear programming computer program is a proprietary software package available only from its manufacturer. [Use of trade names does not imply NMFS endorsement.]

Due to this report having been prepared by an independent contractor, its findings and conclusions do not necessarily represent the National Marine Fisheries Service.

TABLE OF CONTENTS

Section			Page
	Preface		i
	Table of Contents		ii
I.	Introduction		1
II.	Function of a Multifishery Model		2
III.	Description of the Model's Features		6
	A.	Title Section	6
	B.	Operating Environment Section	7
	C.	Data Section	20
	D.	Bounds Section	24
	E.	Constraints Section	25
	F.	Problem Summary	28
IV.	LP83 Results from the Model		29
References			34
Figure 1	Hawaiian Archipelago		9
Appendix A	Hawaii Multifishery Model (Version 1)		
	Item A1	Spreadsheet (values)	A1.1
	Item A2	Spreadsheet (equations)	A2.1
	Item A3	Range Name Listing	A3.1
	Item A4	Variable & Parameter List	A4.1
Appendix B	LP83 Report from Model Run		B1

I. INTRODUCTION

The purpose of this project was to modify and expand on the linear programming (LP) model for Hawaii's commercial fisheries that was developed initially by Dr. Dennis M. King of E.R.G. Pacific, Inc. under a National Marine Fisheries Service (NMFS) contract with the Honolulu Laboratory in 1986 [Ref.1]. The model uses a Lotus 1-2-3 spreadsheet for its structure and runs on a microcomputer using the LP83 commercial software package [Ref.2]. In King's original Hawaii fishery model, several different fleet types could target various fish and crustacean species. Seven submodels were created from this generic model that either increased the specificity of the constraints and/or varied the method of fixed cost accounting. After reviewing these existing 7 submodels, we combined two submodels to form one multifishery model as a new baseline. Many features from the NWHI Bottomfish Fishery LP model, developed in 1988, were incorporated into this new version [Ref. 3].

What linear programming is and how it may be used as a technical aid in making fishery management decisions has been described extensively in Sections II through V of the document for the NWHI Bottomfish LP Model [Ref. 3]. A linear programming model enables the user to simulate different fishery scenarios that may reflect potential industry trends. For example, a manager may wish to examine the effects that changing fish prices, catch rates, annual yields or fishing costs might have on fishing strategies and profitability. However, these scenarios and their resulting solution values MUST NOT be construed as directly applicable to real-world situations. The static nature of linear programming analyses (LP83 assumes that input data will remain the same) precludes such utilization. Instead, LP model results indicate the best potential resource usage given the assumptions, constraints and limitations of a particular model.

This report describes our basic Hawaii multifishery model and its parameters. It includes examples of some typical results with their interpretation.

II. FUNCTION OF A MULTIFISHERY MODEL

There were two primary objectives for developing the Hawaii Commercial Multifishery model:

A. assist in describing the economic interrelationships among the most important fleets; and

B. assist in predicting the economic effects of changes in any of the principal input parameters associated with fishing effort.

Fleets were identified as most important for the Hawaii commercial multifishery from market data collected by the NMFS (Honolulu Lab) over a number of years. Cost estimates used in the model were adjusted from those given in published NMFS reports based on the knowledge of experienced fishery specialists in the Fishery Management Research Program. Other input data were derived from NMFS Honolulu Laboratory fishery management and economic research files.

Due to restraints on the allowable size for a Lotus 1-2-3 spreadsheet, Fleet categories were limited to the five principal economic contributors to the multifishery. Boats were assigned to a category on the basis of various physical characteristics (such as length, hull type, equipment carried, technical sophistication) and method of fishing. In general, two categories are comprised of fairly small boats, two are principally mid to large-size, multipurpose vessels, and one category is allocated to large, high-technology vessels.

Fleet 1 includes trailered and small moored vessels. These boats usually are less than 35 feet in length and fish around the Main Hawaiian Islands. An average fishing trip takes one day. During the summer months, small boats troll for pelagic fish. In the December-January holiday season, bottomfish are the target species.

Fleet 2 contains medium-sized (35-45 feet), moored boats that fish primarily around the outer Main Hawaiian Islands and into the Mau zone of the Northwestern Hawaiian Islands. They employ a variety of fishing techniques during the year, with emphasis on bottomfish, pelagics and large tunas.

Fleet 3 consists of mid-range (45-70 feet), multipurpose boats that may be equipped either for large-scale bottomfishing or for smaller-scale longline fishing.

Fleet 4 vessels, also multipurpose boats, are 70 feet or greater in length and are equipped to engage in medium-scale lobster trapping and/or large-scale longline fishing.

Fleet 5 is reserved for high-technology vessels that are similar in size (70+ feet) to Fleet 4, but have more sophisticated and expensive accommodations and equipment on board. These vessels primarily target crustaceans (lobster and shrimp) that are frequently processed and frozen at sea. Some of these vessels also do longline fishing.

The two multipurpose categories (Fleets 3 and 4) could actually be differentiated into three groups (lobster, bottomfish, and longline) if sufficient computer memory and software capability were available. Additionally, the model does not explicitly account for part-time commercial and recreational fishing activity. This commercial-subsistence-recreational activity could be incorporated into the model's inter-fleet dynamics to some degree by adjusting (to reflect added value) the price premium ratios for target species under Fleets 1 and 2.

In the model, there are four fish and one crustacean species that vessels in each fleet can target.

Species 1 - bottomfish
Species 2 - Pelagic Management Unit Species (PMUS)
(billfish, mahimahi, ono)
Species 3 - lobster
Species 4 - aku (skipjack tunas)
Species 5 - ahi (large tunas - yellowfin, bigeye, albacore)

These species contribute the greatest value to the industry by commanding high prices and/or by having the largest weight percentage in market landings. Constraints are built into the model as to how many pounds of each species can be harvested from each area, as well as a total annual catch limit per species (maximum sustainable yield). Some of these constraints are based on relatively firm biological limits, while others reflect current practices. A table of the catch limits is included in the Operating Environment Section of the spreadsheet (cells BH16 through BM22).

The fishing year is divided into three seasons that are defined by the level of demand for fish as well as traditional northern hemisphere weather designations.

Season 1 - holiday (Dec-Jan)
Season 2 - summer (May-Aug)
Season 3 - winter (Feb-Apr & Sept-Nov)

The actual number of fishing days available to each fleet constitutes the second category of constraints imposed by the model. Fishing days are limited by the number of calendar days in a season as well as by the amount of preparation and travel time needed for a given boat type to reach its fishing destination.

All of the fish species can be caught in any season. However, the crustacean (lobster) is protected (no fishing allowed) during summer months in the Main Hawaiian Islands (Area 1).

Most boats can fish in any of four areas which are delimited roughly along longitudinal lines. [See Figure 1.]

Area 1 - Main Hawaiian Islands (MHI) from the Big Island (Hawaii) to 161° West.
Area 2 - lower Northwestern Hawaiian Islands (NWHI) from 161° West to 170° West.
Area 3 - upper NWHI from 170° West to 185° West.
Area 4 - offshore or open ocean (more than 50 miles from land/atoll).

Small vessels (Fleet 1) for practical reasons are not able to travel beyond the MHI area, and the somewhat larger boats in Fleet 2 usually do not fish outside of the MHI and Mau zones (Areas 1 and 2).

	FLEETS				
AREA	SM T/M	MED MOOR	MED MULT	LGE MULT	CAT/PRO
MHI	+	+	+	+	+
Lower NWHI	-	+	+	+	+
Upper NWHI	-	-	+	+	+
Offshore	-	-	+	+	+

"+" = fleet fishes in the area
"-" = fleet does NOT fish in the area

Some target species are not harvested in all areas. Species 1 (bottomfish) and Species 3 (lobster) are caught on or near the bottom substrate so they are not taken offshore (Area 4).

	SPECIES				
AREA	Bttm	PMUS	Lob	Aku	Ahi
MHI	+	+	+,m	+	+
Lower NWHI	+	+	+	+	+
Upper NWHI	+	+	+	+	+
Offshore	-	+	-	+	+

"+" = species is harvested from area
"-" = species is NOT harvested from area
"m" = species has a closed season in area

All of the possible combinations (omitting the exceptions noted above) of fleet, species, area and season are the fishing situation or fishing effort variables (E-variables) for this model. Associated with each E-variable are several data elements needed by the LP83 program to evaluate that fishing

situation as to its economic potential (marginal net revenue). These elements have been calculated on a fishing day basis for each Fleet and include:

a) average operating cost;
b) crew share and handling costs;
c) catch rate for a given target species; and,
d) average market price for the given target species.

In addition to the E-variables, there are several K-variables representing each fleet-season combination. Input information required by LP83 to compare these K-variables in relation to the E-variables are:

e) minimum and maximum number of boats in a given fleet; and
f) average annual fixed cost per boat in that fleet.

The objective of this multifishery linear program analysis is to maximize the net industry revenue within the limits set for each target species in each area so as not to deplete the fishery resources. LP83 evaluates the model's variables (both E and K) and their input parameters and constraints to determine how much effort in each situation would produce the optimum fleet-wide profit. Effort for the E-variables is measured by the number of available fishing days assigned to that variable after the LP83 evaluation. Effort for the K-variables is demonstrated by LP83 as the number of available boats per fleet that are allowed to participate.

Since the number of choices as to where to apply fishing effort is huge, the solution is practically impossible to visualize. Describing the detail of the results (rather than just the total maximized net revenue and the number of fishing vessels in the solution) is a major impediment in using linear programming analyses. An LP fisheries application usually does not reflect real world situations because of two main factors: (1) open-access fisheries tend toward over-capacity (and thus minimization of industy-wide profits); and (2) the linear program software employs the simplex methodology which does not allocate fishing effort evenly across the feasible range of time and space, but tends to lump it at the smallest possible number of profitable times and spaces (the corner points or vertices of this range).

III. DESCRIPTION OF THE MODEL'S FEATURES

The Hawaiian multifishery LP spreadsheet is used by the LP83 commercial software package as the input or data file. This model presents all of the basic information and parameters that define the linear programming problem to be solved. A math co-processor is also employed with LP83 for increased processing efficiency.

This section explains the various parts of the multifishery model which is printed in standard format in Appendix A, Item 1. To use the printout with the following discussion, pages A1.1 and A1.3-A1.8 are viewed side by side with page A1.2 below page A1.1. Most of the spreadsheet is composed of the long variable list and its associated parameters. For brevity, this repetitive middle section [cells BU through GW] has not been printed. Pages A1.9 - A1.11 are at the lower far right side of the spreadsheet showing the end of the Data and Constraints Sections.

Appendix A, Item 1 is the data entry spreadsheet with its numeric values. Appendix A, Item 2 is the same spreadsheet showing the equations that produce these values. LP83 requires certain range names (identified by the prefix "83") to be defined within the input spreadsheet. Additionally, range names have been given to many other individual cells and groups of cells for convenience. A complete list of the model's range names and their cell locations is presented in Appendix A, Item 3.

A. Title Section

A title is not required by the LP83 program. It is, however, a convenient way to identify each model. The top row of letters and the first column of numbers display the Lotus 1-2-3 cell references. This spreadsheet is called the Hawaii Commercial Multifishery LP Model - Version 1 (cells F2 to I2). Its file name in the Lotus 1-2-3 directory is HCMULT1.WKS (cell A2). Beneath the file name, a Lotus date function is employed to record the last date when modifications were made to the spreadsheet.

A	B	C	D	E	F	G	H
HCMULT1.WKS		** TITLE SECTION			HAWAII COMMERCIAL MULTIFISHERY LP MODEL		
22-Dec-89							

B. Operating Environment Section

Although not directly used by LP83, the environment section defines all of the components that contribute to the variables and their parameters. It extends from cell D4 through cell BT31.

Variables beginning with the letter E (for fishing Effort in bioeconomic terms) represent all the viable permutations of fleet type, target species, area and season that are possible within the context of this model. They are organized in the following manner:

E_{ijkm}

where i = Fleet (boat) type;
j = Target Species;
k = Area; and
m = Season.

The K-variables show the optimal number of boats allowed to participate in each fishing situation (E-variable) that has a corresponding fleet-season combination. Their general format is: K_{i--m}. Since j and k are not influencing fleet size in this model, they have been replaced by dashes. Future versions of the model could be modified to include whatever influence fishing for a particular species (j), or in a certain area (k) may have on fleet size.

Fleet types (the i's) included in this multifishery model are listed with their minimum and maximum number of boats in cells D6 through G11.

(i) = 1 - trailered and small (<35 feet), moored boats
(i) = 2 - medium (35-45 feet), moored vessels
(i) = 3 - mid-range (45-70 feet), multipurpose boats
(i) = 4 - large (>70 feet), multipurpose vessels
(i) = 5 - catcher/processor (high tech) boats

A	C	D	E	F	G	H
2						
3						
4	** OPERATING ENVIRONMENT SECTION					
5						
6		FLEETS		BOATS = MINI	MAXI	
7		FLEET 1 = SM TRAILER/MOOR		150	300	
8		FLEET 2 = MED MOORED		25	50	
9		FLEET 3 = MED MULTIPURPOSE		37.5	75	
10		FLEET 4 = LGE MULTIPURPOSE		10	20	
11		FLEET 5 = CATCHER/PROCESSOR		2.5	5	

For this version (1) of the multifishery model, the maximum number of vessels in each fleet is an approximation of the active commercial participants according to the most recent NMFS information. An "active" participant fishes at least 25 percent of the potential fishing days during the year. Each of these maximum values has been given a range name composed of FLT# where # corresponds to the fleet number.

EXAMPLE: FLT1 (cell G7) = maximum number of boats in FLeeT 1.

In order to ensure that some boats from each fleet are included in the solution, a minimum number of vessels (one-half of the maximum) has been specified. This is an additional constraint built into the model to better represent real-world conditions. These minimum boat values have been given range names with the form FLTO plus the fleet number.

EXAMPLE: FLTO1 (cell F7) = minimum number of boats in FLeeTO 1.

[Note: Both the minimum and maximum fleet configurations can be changed easily, if desired. Setting a minimum number of boats in each fleet that must be given some fishing time is a political decision.]

The five target species (represented by j in the E-variable equation) are listed in cells I6 to J11. They contribute the greatest dollar value to Hawaii's multifishery as a whole.

(j) = 1 - bottomfish
(j) = 2 - pelagic management unit species (PMUS)
(j) = 3 - lobster
(j) = 4 - aku
(j) = 5 - large tuna

Various bottomfish are grouped under Species 1. The PMUS (Species 2) cover species regulated by the Pelagic Species Fishery Management Plan of the Western Pacific Regional Fishery Management Council (WPRFMC). These include all billfish, mahimahi, ono and sharks. Species 3 is comprised mainly of spiny and slipper lobsters. Small tunas (aku) are grouped under Species 4 with large tunas (ahi) in the Species 5 category.

Fishing areas (cells M6 to P10) represent the third element (the k's) in each E-variable. They correspond to the WPRFMC basic fishery management areas. Waters around the main Hawaiian Islands are classified as Area 1. Fishing areas 2 and 3 are in the Northwestern Hawaiian Islands (NWHI), a considerable distance from Honolulu. Area 4 is reserved for open ocean activity - fishing that takes place more than 50 miles offshore. [See Figure 1: a map of the Hawaiian Archipelago.]

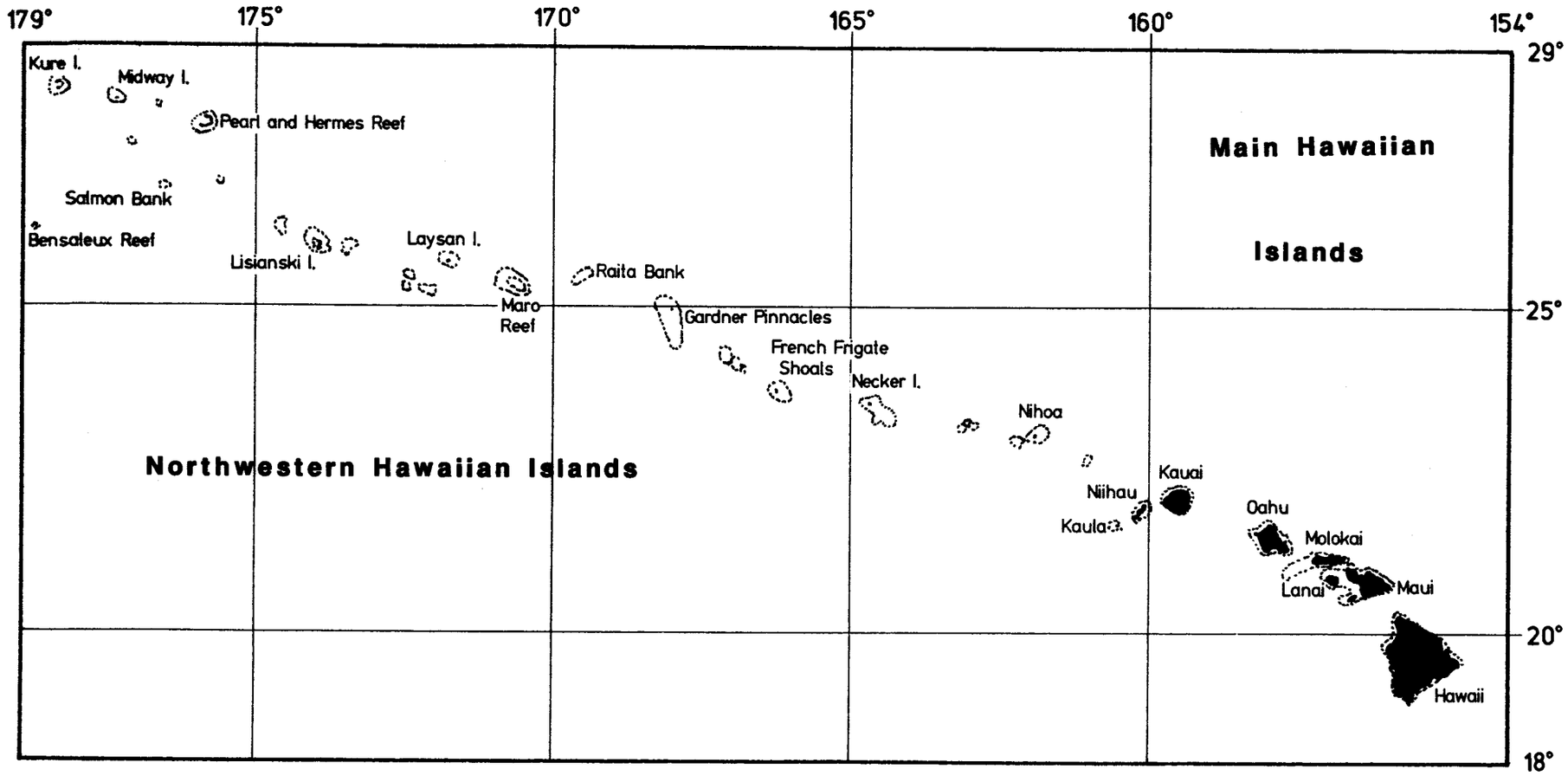

Figure 1.--Hawaiian Archipelago.

(k) = 1 - Main Hawaiian Islands (to 161° W)
(k) = 2 - lower NWHI (161° - 170° W)
(k) = 3 - upper NWHI (170° - 185° W)
(k) = 4 - offshore (>50 miles)

The last element in an E-variable (the m's) indicates a Season (cells S6 to T10). These are defined by both weather and market demand characteristics. Holiday (Season 1) refers to the Christmas-New Year period of very high demand. Season 2 is reserved for the summer months (northern hemisphere), and Season 3 encompasses the remainder of the year (mostly winter). The number of calendar days in each season appears to the right (cells V5 to W9). Range names for these calendar day values are defined below.

(m) = 1 - SEAH (cell W7) - SEAson Holiday [Dec-Jan]
(m) = 2 - SEAS (cell W8) - SEAson Summer [May-Aug]
(m) = 3 - SEAW (cell W9) - SEAson Winter [Feb-Apr & Sep-Nov]

The E-variables listed in row 38 (cells G38 through GZ38) represent combinations of the forgoing fleets, species, areas and seasons. They can be interpreted according to the following example.

EXAMPLE: E2431 is the fishing Effort (sum of fishing days for all participating boats) of Fleet 2 (medium-sized, moored vessels) catching Species 4 (aku) in Area 3 (upper NWHI) during Season 1 (Holiday: Dec-Jan).

FISHING DAYS PER TRIP (cells AA5 through AB11) are averaged values assigned to each Fleet (1-5). These averages are calculated from the most recent Honolulu Lab fishing trip data. Each value has a range name with the format shown in brackets []. This acronym stands for Average Fishing Day for Fleet *i* (where *i* is the respective fleet number).

EXAMPLE: AFDF3 (cell AB9) = Average number of Fishing Days per trip for vessels in Fleet 3.

	AA	AB
4		
5	FISHING DAYS PER TRIP	
6	(ANNUAL AVERAGE) [AFDFi]	
7	SM T/M	0.8
8	MED MRD	3.5
9	MED MULT	7
10	LGE MULT	38
11	CAT/PRO	44

AVERAGE RUNNING DAYS IN AREA PER TRIP (cells AE5 to AF10) refers to the amount of time a vessel (no specific type) would take to travel to the designated

fishing region. These values also were derived from trip information collected by the staff at NMFS, Honolulu Lab. Range names given to these values have the form ARDA*i* (where *i* is the respective Area number).

EXAMPLE: ARDA2 (cell AF8) = Average number of Running Days per trip for a boat (in general) to reach Area 2 (lower NWHI) from Honolulu.

The next number set to the right shows AVERAGE RUNNING DAYS BY FLEET PER TRIP (cells AH5 to AI11). These values represent the average traveling time a vessel in a given fleet would require for a fishing trip (no specific area). They are determined from an equation that averages the running days to specific areas (the ARDA*i*,s in cells AF7 to AF10) in which the fleet usually fishes. For example, Fleet 1 usually fishes in Area 1, so its value is equal to ARDA1. Fleet 4 fishes in all areas so its value is an average of all the ARDA*i*,s. Range names for this number set have format ARDF*i* (where *i* is the Fleet number).

EXAMPLE: ARDF4 (cell AI10) = Average number of Running Days per trip (in general) for a large, multipurpose boat (Fleet 4).

AD	AE	AF	AG	AH	AI	AJ
4						
5	AVERAGE RUNNING DAYS IN			AVERAGE RUNNING DAYS BY		
6	AREA PER TRIP [ARDAi]			FLEET PER TRIP [ARDFi]		
7	MHI	0.3		SM T/M	0.3	
8	LOW NWHI	4		MED MRD	2.2	
9	UP NWHI	8		MED MULT	5	
10	OFFSHORE	3		LGE MULT	5	
11				CAT/PRO	5	

The next section to the right is POTENTIAL TRIPS (PER BOAT) PER SEASON (cells AL4 through AO11). The values for each fleet in each season were calculated with a formula that divides the calendar days in a given season [using the range names under Calendar Days (cells W7-W9)] by the average operating days per trip for a given fleet in a particular season [range names with format OD*ii* (cells Q18 through S22)]. The form for range names of Potential Trip values is PT*ii*.

EXAMPLE: PT13 (cell AO7) = Potential Trips of fleet 1 in season 3

AK	AL	AM	AN	AO	AP
4		POTENTIAL TRIPS (PER BOAT)			
5		PER SEASON [PTii]			
6		Holiday	Summer	Winter	
7	SM T/M	30	71	70	
8	MED MRD	8	13	20	
9	MED MULT	4	7	11	
10	LGE MULT	1	2	4	
11	CAT/PRO	1	2	3	

ANNUAL FIXED COSTS PER VESSEL (cells AR5 through AS11) are costs that recur every year independent of the daily expense to operate a vessel. Items included under fixed costs are capital expenses (boat mortgage payments), dry-dock and overhaul expenses, insurance coverage, etc. Information from several NMFS publications was adjusted by Fishery Management Research Program people experienced in the fisheries to determine an average fixed cost for each fleet type. Specific fleet data sources are:

trailered and small, moored boats - [Ref. 4]
medium-sized, moored vessels - [Ref. 5]
medium-sized multipurpose boats - [Ref. 6]
large-sized multipurpose vessels - [Ref. 7]
catcher/processor vessels - [Ref. 8]

The range names (format FCV*i*) for this section represent fixed costs per vessel in a Fleet type.

EXAMPLE: FCV3 (cell AS9) = Fixed Costs per Vessel in fleet 3

	AQ	AR	AS	AT
4				
5		ANNUAL FIXED COSTS		
6		PER VESSEL [FCVi]		
7		SM T/M	$6,800	
8		MED MRD	$20,000	
9		MED MULT	$50,000	
10		LGE MULT	$130,000	
11		CAT/PRO	$380,000	

Further to the right is a table titled PREMIUM PRICE RATIO BY FLEET/SPECIES (cells AW5 through BA12). These numbers are estimates (based on market data) of the comparative worth a given target species has if landed by a vessel of the designated fleet type in relation to other fleet types. A ratio of one is average or the norm. Ratios greater than one (1.25 or 1.50) indicate landings by that fleet type are typically worth more than the average market price for the associated species. Ratios less than one (.74 or .50) show fleets that tend to earn below normal market price for that species. Range names for these ratios have the form PP*ii*.

EXAMPLE: PP53 (cell AY11) = Price Premium ratio for fleet 5 landing species 3.

Directly under the Premium Price Table is listed the Average Market Price per pound obtained at market during the 1988-1989 period for each species. These prices are for pounds (whole) of wet weight. The format for their range names is APS*i*.

EXAMPLE: APS2 (cell AX12) = Average market Price of Species 2

	AT	AU	AV	AW	AX	AY	AZ	BA
3								
4								
5				PREMIUM PRICE RATIO BY FLEET/SPECIES [PPii]				
6				Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7			SM T/M-Flt 1	1.25	1.25	1.00	1.10	0.75
8			MED MR-Flt 2	1.25	1.50	1.00	1.00	0.75
9			M.MULT-Flt 3	1.00	1.00	1.00	1.00	1.25
10			L.MULT-Flt 4	0.75	0.75	1.00	0.70	1.00
11			CAT/PR-Flt 5	0.50	0.50	1.00	0.50	0.50
12		Average	Price [APSi]	$2.65	$1.50	$4.02	$1.10	$2.35
13								

The Premium Price table and the species Average market Price values are used along with other elements to generate the target species market price (p) associated with each E-variable in the Data Section.

Another table of ratio values appears under CATCH RATIO FLEET/SEASON (cells BC5 through BF11). These ratios indicate the catchability or comparative degree of fishing success (measured in pounds of target species caught per day) that a designated fleet type has in a given season. Values of 1 represent average success or the norm. Values greater than 1 identify fleets that usually catch more per day during the associated season than throughout the rest of the year. Values less than 1 simulate poor weather conditions where catch is relatively less than the norm. These ratios have range names with the format qF*im*.

EXAMPLE: qF22 (cell BE8)= catch (q) ratio for Fleet 2 in season 2

The next table at the top of the spreadsheet is called the AVERAGE CATCH RATE (q) FLEET/SPECIES (cells BH5 through BM11). It contains the average amount (in pounds per fishing day) of a target species that is caught by a given fleet. These averages are based on NMFS market data from tha 1988-1989 period. Range names for this table have the format qF*i*S*i*.

EXAMPLE: qF4S2 (cell BJ10) = catch rate (q) for Fleet 4 of Species 2

BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM
3											
4											
5		CATCH RATIO FLEET/SEASON [qFim]					AVERAGE CATCH RATE (q) FLEET/SPECIES [qFiSi]				
6		Holiday	Summer	Winter			Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7	SM T/M	0.80	1.25	0.75		SM T/M	60	50	25	50	150
8	MED MRD	1.00	1.50	0.75		MED MRD	70	65	50	100	300
9	MED MULT	1.00	1.25	0.85		MED MULT	1000	750	500	500	750
10	LGE MULT	1.00	1.25	0.85		LGE MULT	780	750	920	1500	1500
11	CAT/PRO	1.00	1.10	0.90		CAT/PRO	750	750	1540	750	1500
12											

CATCH (q) RATIO AREA/SPECIES (cells BO5 through BT10) is the last table of ratios needed for adjusting the catch rates (q) under each E-variable. It reflects area differences in species abundance. In some areas (MHI) where fishery resources have been exploited for many years, species populations have declined markedly, making fishing effort less successful. These regions are given ratio values less than 1 (the norm). Ratio values greater than 1 indicate areas where the catchability of a species is better than the norm (due to less intensive fishing effort in the past). Zero indicates that a species is not harvested in this area. Range names for these elements have the format qA*i*S*i*.

EXAMPLE: qA2S3 = catch (q) ratio in Area 2 for Species 3 (cell BR8)

A	BN	BO	BP	BQ	BR	BS	BT	BU
4								
5				CATCH (q) RATIO AREA/SPECIES [qAiSi]				
6			Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI	
7		Ar 1- MHI	0.8	0.8	0.6	1.0	0.8	
8		Ar 2-Lw NWHI	1.2	1.2	1.2	1.0	1.0	
9		Ar 3-Up NWHI	1.0	1.2	1.4	1.0	1.0	
10		Ar 4-OffShor	0.0	1.0	0.0	1.0	1.2	
11								
12								

The Catch Ratio per Fleet/Season values (qF*ii*'s), Average Catch Rate table (qF*i*S*i*'s), and Catch Ratio per Area/Species values (qA*i*S*i*'s) are used to generate each fishing situation (E-variable) catch rate (q) in the Data Section of the spreadsheet.

The second level of value groups in the Operating Environment Section begins with EXPECTED TOTAL POTENTIAL FISHING DAYS PER BOAT PER SEASON (cells D15 through I22). The values in this set are the result of multiplying the appropriate fleet/season Potential trips [range names PT*ii* in cells AM7 through AO11] by its fleet/season counterpart in Average (per Trip) Fishing Days Per Season [range names FD*ii* in cells AA18 through AC22]. Range names given to this set have the form FiS*i* (cells F18 through H22).

EXAMPLE: F1S1 (cell F18) = potential fishing days available for Fleet 1 in Season 1

The last column in this set contains the sum of potential fishing days available to a given fleet per year. Equations for these sums use the appropriate range names (F*i*S*i*,s) for each fleet/season value. Range names have also been given to this column of values (format TFD*i*).

EXAMPLE: TFD3 (cell I20) = Total annual Fishing Days for fleet 3

A	C	D	E	F	G	H	I
13							
14							
15				EXPECTED TOTAL POTENTIAL FISHING			
16				DAYS PER BOAT PER SEASON [FiSi]			
17				Holiday	Summer	Winter	Total [TFDi]
18		FLEET 1 = SM TRAILER/MOOR		24	68	51	143
19		FLEET 2 = MED MOORED		27	56	64	147
20		FLEET 3 = MED MULTIPURPOSE		28	59	67	154
21		FLEET 4 = LGE MULTIPURPOSE		50	101	137	288
22		FLEET 5 = CATCHER/PROCESSOR		49	95	129	273

The next group to the right is TOTAL POTENTIAL OPERATING DAYS PER SEASON (cells K15 through N22). These values represent the Potential Trips (range names PT*ii* in cells AM7 through AO11) <u>times</u> the Average (Per Trip) Operating Days (range names OD*ii* in cells Q18 through S22) within the appropriate fleet by season category. Range names for this section have the format OF*i*S*i* (in brackets).

EXAMPLE: OF2S3 (cell N19) = potential <u>O</u>perating days for <u>F</u>leet <u>2</u> in <u>S</u>eason <u>3</u>

A	K	L	M	N	O
14					
15		TOTAL POTENTIAL OPERATING			
16		DAYS PER SEASON [OFiSi]			
17		Holiday	Summer	Winter	
18	SM T/M	60	120	180	
19	MED MRD	60	120	180	
20	MED MULT	60	120	180	
21	LGE MULT	60	120	180	
22	CAT/PRO	60	120	180	

Under AVERAGE (PER TRIP) OPERATING DAYS (cells P15 through S22) the sum of the Average (per trip) Fishing Days [range names FD*ii* in cells AA18 through AC22], Average (per trip) Running Days [range names RD*ii* in cells AF18 through AH22], and Average (per trip) Turn-around Days [range names TD*ii* in cells V18 through X22] is calculated for each fleet by season combination. An Annual Average (cell S23) indicates the average of all values in this table. It will be used in other calculations. Range names for this table are of the form OD*ii*.

EXAMPLE: OD32 (cell R20) = average <u>O</u>perating <u>D</u>ays per trip for fleet <u>3</u> in season <u>2</u>

A	P	Q	R	S	T
14					
15		AVERAGE (PER TRIP)			
16		OPERATING DAYS [ODii]			
17		Holiday	Summer	Winter	
18	SM T/M	2.0	1.7	2.6	
19	MED MRD	7.7	9.0	8.8	
20	MED MULT	15.0	17.2	17.1	
21	LGE MULT	46.0	54.4	45.0	
22	CAT/PRO	54.0	66.6	55.4	
23		Annual Average =		26.8	

AVERAGE (PER TRIP) TURN-AROUND DAYS (cells U15 through X22) are values taken from NMFS records about fishing trips. The format for range names in this set is TD*ii* (in brackets).

EXAMPLE: TD41 (cell V21) = average Turn-around Days for fleet 4 in season 1

A	U	V	W	X	Y
14					
15		AVERAGE (PER TRIP)			
16		TURN-AROUND DAYS [TDii]			
17		Holiday	Summer	Winter	
18	SM T/M	0.9	0.5	1.5	
19	MED MRD	2	3.2	3.2	
20	MED MULT	3	5	5	
21	LGE MULT	3	5	5	
22	CAT/PRO	5	10	10	
23					

AVERAGE (PER TRIP) FISHING DAYS PER SEASON (cells Z15 through AC22) are calculated by multiplying the fleet Annual Average Fishing Days per trip (range names AFDF*i* in cells AB7-AB11) by a rate value (given below the appropriate column in row 23) for that season. These rates are an estimate of seasonal influence on the number of fishing days per trip. Most boats take shorter trips during winter months due to stormy, high-wind weather conditions. They tend to stay out longer in the summer months. Range names with format FD*ii* were given to values in this set.

EXAMPLE: FD53 (cell AC22) = average Fishing Days for fleet 5 in season 3

A	Y	Z	AA	AB	AC	AD
4						
5			FISHING DAYS PER TRIP			
6			(ANNUAL AVERAGE) [AFDFi]			
7			SM T/M	0.8		
8			MED MRD	3.5		
9			MED MULT	7		
10			LGE MULT	38		
11			CAT/PRO	44		
12						
13						
14						
15			AVERAGE (PER TRIP)			
16			FISHING DAYS PER SEASON [FDii]			
17			Holiday	Summer	Winter	
18		SM T/M	0.80	0.96	0.72	
19		MED MRD	3.50	4.20	3.15	
20		MED MULT	7.00	8.40	6.30	
21		LGE MULT	38.00	45.60	34.20	
22		CAT/PRO	44.00	52.80	39.60	
23		RATE =	1	1.2	0.9	
24						

AVERAGE (PER TRIP) RUNNING DAYS (cells AE15 through AH22) result from multiplying the appropriate Average Running Days by Fleet per Trip (range names ARDF*i* in cells AI7-AI11) <u>times</u> the rate given below each column in row 23. These rate values are an estimated adjustment for the seasonal differences in travel time required per trip. It usually takes longer to travel a given distance in winter months when seas are high and rough due to storms. The values of this set have range names with format RD*ii*.

EXAMPLE: RD32 (cell AG20) = average <u>R</u>unning <u>D</u>ays for fleet <u>3</u> in season <u>2</u>

A	AD	AE	AF	AG	AH	AI	AJ
HC1A1.WKS							
22-Dec-89							
4							
5					AVERAGE RUNNING DAYS BY		
6					FLEET PER TRIP	[ARDFi]	
7					SM T/M	0.3	
8					MED MRD	2.2	
9					MED MULT	5	
10					LGE MULT	5	
11					CAT/PRO	5	
12							
13							
14							
15			AVERAGE (PER TRIP)				
16			RUNNING DAYS [RDii]				
17			Holiday	Summer	Winter		
18		SM T/M	0.30	0.23	0.35		
19		MED MRD	2.15	1.61	2.47		
20		MED MULT	5.00	3.75	5.75		
21		LGE MULT	5.00	3.75	5.75		
22		CAT/PRO	5.00	3.75	5.75		
23		RATE =	1	0.75	1.15		
24							

ACTUAL TRIPS (PER BOAT) PER SEASON (cells AL15 through AO22) are derived from dividing the appropriate fleet/season Actual Fishing Days per Boat (cells F27 through H31) by the corresponding fleet/season Average per Trip Fishing Days per Season (range names FD*ii* in cells AA18 through AC22). These values are not used in any calculations, but they are included for comparison with the Potential Trips (the PT*ii*'s) numbers in the section above (same columns). The numbers should be similar if LP83 uses all available fishing days.

A	AK	AL	AM	AN	AO	AP
14						
15			ACTUAL TRIPS (PER BOAT)			
16			PER SEASON			
17			Holiday	Summer	Winter	
18		SM T/M	30	58	70	
19		MED MRD	8	13	0	
20		MED MULT	4	7	11	
21		LGE MULT	1	2	4	
22		CAT/PRO	1	2	3	
23						

AVERAGE (PER DAY) OPERATING COSTS (cells AR15 - AS22) are estimates of what a typical boat in each fleet type would spend per day to function on a trip. Items covered under this category are fuel, ice, bait, supplies, gear, food, etc. A complication in estimating operating costs is that the model is based on fishing days (df), while most vessel costs are calculated on days at sea (das). As a result, operating costs initially may appear to be excessive, but the problem is resolved when realizing that operating costs per fishing day may need to include a nearly equivalent value to cover running days. The relationship between running days and days at sea can vary substantially over various classes and types of vessels. For example, NWHI bottom fishing boats fish less than 50% of their days at sea, the remainder being spent in transit. The same vessels, when outfitted for longline tuna fishing, can fish 70% of their days at sea. In order to keep the data entry section of this model tractable, compromises had to be made in estimating operating costs. Range names with format OCV*i* were provided for this set.

EXAMPLE: OCV4 (cell AS21)= Operating Costs for Vessels in fleet 4

AQ	AR	AS
14		
15	AVERAGE (PER DAY)	
16	OPERATING COSTS [OCVi]	
17		
18	SM T/M	$125
19	MED MRD	$200
20	MED MULT	$1,050
21	LGE MULT	$900
22	CAT/PRO	$1,515

The AREA COST RATIO values (cells AW16 - AX21) adjust for the variation in expenses involved with different fishing areas. More distant regions incur greater costs in fuel consumption, hauling extra supplies to keep fish fresh, and supporting the crew. The ratios are computed by dividing the Overall Annual Average Operating Days value (cell S23) by the difference between this same overall value and the average Running Days (the ARDA*i*'s) for the corresponding area. Range names provided for these values have form CRA*i*.

EXAMPLE: CRA2 (cell AX19) = Cost Ratio for Area 2

AV	AW	AX
15		
16	AREA COST	
17	RATIO [CRAi]	
18	Ar 1- MHI	1.01
19	Ar 2-Lw NWHI	1.18
20	Ar 3-Up NWHI	1.43
21	Ar 4-Offshor	1.13

SEASON PRICE RATIO (cells AZ16-BA20) is a value used to adjust the fish price (p) associated with each fishing situation (E-variable) to reflect seasonal influence. Market data show that fish draw the best price during the high-demand holiday season, whereas demand for fish is slack in summer months. Winter season (SEAW) is given the average ratio designation of 1. Values for the holiday (SEAH) and summer (SEAS) season ratios are set relative to this norm. Range names for this group are of the form PRS*i*.

EXAMPLE: PRS1 (cell BA18) = Price Ratio of Season 1

AV	AZ	BA
15		
16	SEASON PRICE	
17	RATIO [PRSi]	
18	SEAH =	1.50
19	SEAS =	0.75
20	SEAW =	1.00

CREW SHARES (cells BD16-BE22) are estimated, average percentages of a boat's gross revenue for the vessels within a given Fleet according to NMFS trip data. These percentages are used to calculate crew share costs (cs) which are then subtracted from the marginal net revenue for each E-variable (83COST). Range names given to this number set have form CSH*i*.

EXAMPLE: CSH2 (cell BE19) = Crew SHare for fleet 2

BC	BD	BE
15		
16	CREW SHARES [CSHi]	
17	(% of boat revenue)	
18	SM T/M	0.30
19	MED MRD	0.40
20	MED MULT	0.47
21	LGE MULT	0.36
22	CAT/PRO	0.40

SPECIES POUNDAGE LIMITS (Q) BY AREA (cells BH16 through BM21) is a table of the maximum number of pounds of a target species that can be harvest per year in each area. Beneath the table (row 22) the total poundage limit from all areas for each species per year (maximum sustainable yield) is given. These are the same values that appear to the right of the equivalent sign for the Q equations in the Constraints Section (HQ60-HQ82).

A	BH	BI	BJ	BK	BL	BM
14						
15						
16			SPECIES POUNDAGE LIMITS (Q) BY AREA			
17		Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
18	Ar 1- MHI	627,000	4,687,500	12,500	15,000,000	15,000,000
19	Ar 2-Lw NWHI	126,000	4,687,500	656,250	15,000,000	15,000,000
20	Ar 3-Up NWHI	474,000	4,687,500	1,218,750	15,000,000	15,000,000
21	Ar 4-OffShor	0	7,500,000	0	15,000,000	15,000,000
22	TOTAL LBS	1,227,000	7,500,000	1,500,000	15,000,000	15,000,000
23						

The last level of the Operating Environment Section contains a table labeled ACTUAL FISHING DAYS (PER BOAT) in cells E25-H31. These numbers are the fishing days assigned by the LP83 program using infomation from the Data Section of this model. Since LP83 will try to utilize all available fishing days, the values in this section should be close to, or the same as, those in the section above (Expected Total Potential Fishing Days per Boat per Season). The equations for these numbers add all of the solution values (assigned fishing days) under each E-variable included within a fleet/season (E#--#) category and divide this sum by the number of boats fishing in that Fleet type (K-variable).

A	B	C	D	E	F	G	H	I
24								
25					ACTUAL FISHING DAYS (PER BOAT)			
26					Holiday	Summer	Winter	
27				Fleet 1-SM T/M	24	56	51	
28				Fleet 2-MED MR	27	56	0	
29				Fleet 3-M.MULT	28	59	67	
30				Fleet 4-L.MULT	50	101	137	
31				Fleet 5-CAT/PR	49	95	129	
32								

C. Data Section

This part of the spreadsheet (cells C35 through HP57) contains the objective of the model and all of the activity variables with their parameters needed for the LP83 program to provide a solution to this model's problem. The goal is to maximize the net revenue for Hawaii's multifishery taken as a whole subject to the constraints built into the model [area D58-HQ97].

Row 38 lists all of the problem's activity variables, which includes both the E and the K variables. It is a requirement of the LP83 package and has the range name 83VARIABLE (cells G38-HO38).

E	F	G	H	I
37				
38	VARIABLE LIST->	E1111	E1112	E1113

Since there are five vessel types, five species groups, four areas, and three seasons, the potential number of E-variables for this model is 5 X 5 X 4 X 3 = 300. Because of the various limitations described earlier as to fleet traveling capability, seasonal harvest regulations, and species area availability, fishing situations with these characteristics (98) have been excluded. Hence, the final list for the model contains 202 E-variables. [If no such natural exclusions exist in a problem, it may be necessary to artificially restrict the number of variables so that the model does not exceed the computer's memory capacity.]

In addition to the E-variables, there are fifteen K-variables (cells HA38-HO38) representing the number of boats actively fishing in each Fleet/Season category.

	HA	HB	HC
37			
38	K1--1	K1--2	K1--3

Row 40 has been set aside for the solution values (fishing days assigned to each E-variable and number of boats included per Fleet/Season category (K-variable) to be returned from the LP83 evaluation. The LP program range name for these values is 83VA. In addition to the variable values, one cell (HP40) has been assigned to hold the fleetwide profit calculated by LP83.

The variable parameters begin in row 41 and extend through row 51. All E-variable parameter values represent amounts per fishing day. They could also be calculated on an operating day or an annualized basis.

A	D	E	F	G	H	I	J
38			VARIABLE LIST->	E1111	E1112	E1113	E1211
39		** ECONOMIC PARAMETERS	----------				
40		** SOLUTION VALUES			8360		
41		* DAILY CATCH RATE (q)		48	75	45	40
42		* FISH PRICE (p)		$4.97	$2.48	$3.31	$2.81
43		* REVENUE (R)		$238.50	$186.33	$149.06	$113.40
44		* DAILY OPERATING COST (c)		$101.13	$101.13	$101.13	$101.13
45		* HANDLING COST (hc)		$23.85	$18.63	$14.91	$11.34
46		* CREW SHARE COST (cs)		$34.06	$19.97	$9.91	$0.28
47		* ANNUAL FIXED COST/VESSEL					
48		* CATCH PER Eijkm		0	627000	0	0
49	** OBJECTIVE FUNCTION - MAX FLEETWIDE PROFIT	*******					
50		* MARGINAL REVENUE		$79.46	$46.59	$23.12	$0.65
51		* NET REVENUE BEFORE FC		$0	$389,530	$0	$0

Daily catch rate (q) in row 41 is the average pounds of a target species caught for a particular fishing situation (E-variable) per fishing day. Range names from the catch ratio and catch rate tables of the Operating Section are

used to generate these values. The average catch rate for a particular fleet/species category is adjusted by the corresponding fleet/season and area/species ratios. Equations have the general format:

q = QF*ii* X QF*i*S*i* X QA*i*S*i*

Values for Fish Price (p) in row 42 are produced from a formula that utilizes range names from the average species' price, premium price table and season price ratios. In order to account for fleet type and seasonal influences on a species' market value, the average species' price of the target species in a given E-variable is modified by the appropriate ratios from the Premium Price and Season Price tables. The structure of the formula is:

p = PP*ii* X APS*i* X PRS*i*

Revenue (R) has been included (row 43) for each variable as a convenience for the user. It is not used by the LP83 program directly. The value represents the income a given fishing situation would earn per fishing day if it participates in the solution. Revenue equals the species poundage caught (q) times the market price obtained (p) in a fishing situation.

R = q X p

Daily Operating Cost (c) in the next row (44) is a product of the particular fleet Average (per Day) Operating Costs (range names OPC*ii*) and the Area Cost Ratio (range names CRA*i*) appropriate for that fishing situation.

c = OCV*i* X CRA*i*

Handling costs (hc) and Crew Share costs (cs) are identified separately in this model, although they could be incorporated into the daily operating costs (c). Handling costs (row 45) are estimated as 10 percent of the revenue (R). Crew share (row 46) is calculated as the percentage for a given fleet type (range names CSH*i*) times the remainder of the revenue (R) after subtracting the daily operating costs (c) and the handling costs (hc). The general equations are:

Handling Costs (hc) = R X .1

Crew Share Costs (cs) = [R - (c + hc)] X CSH*i*

Annual fixed costs appear in row 47, associated with the K-variables at the end of the row (cells HA47-HO47). The average annual fixed cost for a vessel in a particular fleet has been distributed seasonally, based on the number of calendar days in the season. Fixed costs are not attributed to specific fishing situations (E-variables).

A	HA	HB	HC
37			
38	K1--1	K1--2	K1--3
39	------	------	------
40	300	150	150
41			
47	$1,142	$3,253	$2,404

The method for calculating this fixed cost for each K-variable is to multiply the given fleet's average fixed cost per boat value (range names FCV*i*) by the ratio of that fleet's expected potential fishing days per boat per season (the F*i*S*i* range names in cells F18-H22) and the fleet's total annual potential fishing days (the TFD*i* range names in cells I18-I22). Its general equation format is:

Fixed Cost (per fleet per season) = FCV*i* X (F*i*S*i*/TFD*i*)

When LP83 evaluates the aggregate demand for fishing days, fixed costs attributed to a particular season for each vessel employed by a fleet will be included in calculating total cost. However, since this version (1) of the multifishery model has a requirement that a minimum number of boats must be allowed to participate in each fleet, the LP83 program includes at least this minimum number for each fleet in each season in its solution <u>regardless</u> of whether any fishing days have been assigned to any of the corresponding E-variables. This means that in calculating the fleetwide profit for Version 1, LP83 subtracts <u>at least</u> half of a fleet's total annual fixed cost amount from the revenues generated, even if fishing did not actually occur. If there were NO <u>minimum</u> number of boats for each fleet in the model, the portion of fixed costs currently associated with fleets that are not fishing in a particular season would not be counted in calculating fleetwide profit.

Catch per E_{ijkm} in row 48 contains the total species poundage caught per fishing situation. If an E-variable is NOT included in the solution, then this value will be 0. For participating E-variables, the value is a product of the number of fishing days allocated (row 40) and the daily catch rate (q).

Catch = fishing days X q

The goal of the model, summarized in row 49, marginal net revenue, is to maximize fleetwide (multifishery industry) profit. Each E or K variable must have a profit or loss "cost" margin associated with it for the LP83 analysis. These values appear in row 50 (labeled Marginal Revenue). For the E-variables, a cost margin represents a fishing situation's potential income (R) minus all associated expenses - daily operating costs (c), handling costs (hc), and crew share costs (cs). The equation for calculating E-variable marginal net revenue (MR) has the general form:

MR (E-variable) = R - [c + hc + cs] (for cs => 0)

Marginal net revenue for the K-variables is their negative fixed cost value. The equation is similar to marginal revenue above except that fixed costs (FC) in row 47 are subtracted from revenue (R). Since R is 0 for the K-variables, these cost margin values are the negative fixed cost amount.

MR (K-variable) = R - FC

The range name set aside within the LP83 program for the marginal revenue row is 83COST (cells G50 - H050).

For user convenience, a calculation of the net revenue before fixed costs (FC) are subtracted has been provided in the following row (cells G51 - H051). Net revenue before FC is produced by multiplying the assigned fishing days (row 40) times the marginal revenue (row 50). If an E-variable is NOT included in the solution (no fishing days assigned), then the value will be 0.

Values appearing in this row (51) for the K-variables represent the total fixed costs for a given fleet in that season. It is a product of the number of boats included for that fleet (row 40) times the fleet's average fixed cost per boat for that season (row 50). The general equation format is:

Total (per season) fleet Fixed Cost = (# of boats) X FC

Since this model has a minimum boat requirement, all fleets have at least the minimum number of boats in each season included in the analysis, even if they did not fish. This increases fleet-wide and industry-wide fixed costs for solutions when less than half of a fleet's boats fish in any season.

D. Bounds Section

This section, required by LP83, defines the range that solution values may have for each variable. The smallest number (Lower Bounds in row 54) of fishing days that can be assigned to an E-variable is 0. LP83 program range name for this row is 83LOWER.

The greatest number of fishing days (Upper Bounds in row 56) that the LP83 program may allocate for an E-variable is determined by a formula based on the maximum number of boats available to the fishing situation's fleet type (range names FLT# in cells G7-G11) and the Expected Total Potential Fishing days per boat of that fleet type in the given season (range names F*i*S*i* in cells F18-H22). The equation's general format is:

Upper Bound for E_{i--m} = FLT# X F*i*S*i*

This row's LP83 program range name is 83UPPER.

A	D	E	F	G	H	I	J	K
52	** BOUNDS **********			Effort Level Bounds (Based on Calendar Constraints)				
53			Fishing Days					
54		* LOWER BOUNDS		0	0	0	0	0
55								
56		* UPPER BOUNDS		7200	20510	15158	7200	20510

The lower limit for each K-variable equals its fleet type minimum boat number (range names FLTO# in cells F7-F11), and the upper limit reflects that fleet type's maximum vessel number (range name FLT# in cells G7-G11).

E. Constraints Section

Various inequalities that exist among the variables of the problem are delineated in this sector of the spreadsheet. It is essential for the LP83 program, and serves to define the constraints on the problem's (i.e., the fishery's) resources. Each constraint's relationship (<=, >=, =) to its resource limit value [right hand side (RHS)] is presented.

Constraints under species poundage per area [Q-jk-] indicate the maximum amount of the species available in that area. Under each fishing situation (E-variable) with the appropriate species-area designation, its demand on the area's species poundage is represented by its catch rate (q).

A	D	E	F	G	H	I	J	K
57								
58	** CONSTRAINTS **********							
59								
60		* Q LIMITS	Q-11-	48	75	45		
61			Q-12-					
62			Q-13-					
63			Q-1--	48	75	45		
64			Q-21-				40	63
65			Q-22-					
66			Q-23-					
67			Q-24-					
68			Q-2--				40	63

For each species there is also a cumulative constraint row (labeled Q-j--) specifying the total amuount of a species (maximum sustainable yield or MSY) that can be harvested from all areas. Species poundage is usually distributed among several variables and when this maximum yield amount is reached, no more fishing days can be assigned by LP83 to any E-variable containing that species.

Occasionally, one particular fishing situation with a given species may be favored. In this case LP83 will allocate sufficient fishing days to that E-variable to use up all of this species maximum yield amount, thereby excluding other fishing situations from that species' fishery.

The annual limits (RHS) listed opposite the relational sign in column HQ60-HQ82 for each Q category represent maximum allowable annual yields calculated by NMFS fishing specialists involved in collecting and analyzing species' data. Values for bottomfish (Q-1--) and lobster (Q-3--) more closely reflect realistic sustainable poundage yields because the circumscribed range of these species permits a more comprehensive assessment of the resource's dimensions. Poundage limits for highly mobile pelagic species (Q-2--, Q-4--, Q-5--), however, are based on the greatest market landings most recently reported and may not be a truly sustainable harvest yields.

A	HP	HQ	HR	HS
59				
60	<=	627,000	Q LIMITS Q-11-	
61	<=	126,000	Q-12-	
62	<=	474,000	Q-13-	
63	<=	1,227,000	Q-1--	
64	<=	4,687,500	Q-21-	
65	<=	4,687,500	Q-22-	
66	<=	4,687,500	Q-23-	
67	<=	7,500,000	Q-24-	
68	<=	7,500,000	Q-2--	
69	<=	12,500	Q-31-	
70	<=	656,250	Q-32-	
71	<=	1,218,750	Q-33-	
72	<=	1,500,000	Q-3--	
73	<=	15,000,000	Q-41-	
74	<=	15,000,000	Q-42-	
75	<=	15,000,000	Q-43-	
76	<=	15,000,000	Q-44-	
77	<=	15,000,000	Q-4--	
78	<=	15,000,000	Q-51-	
79	<=	15,000,000	Q-52-	
80	<=	15,000,000	Q-53-	
81	<=	15,000,000	Q-54-	
82	<=	15,000,000	Q-5--	

The E labeled constraints (F83-H097) indicate with a 1 whether an E-variable should be included with the set defined by the given label. For example, E3--1 includes all fishing situations where Fleet 3 fishes for any species in any area in Season 1.

A	D	E	F	G	H	I	J	K
83		* E LIMITS	E1--1	1			1	
84			E1--2		1			1
85			E1--3			1		

The constraint values for the K-variables at the end of each row are the Total Expected Potential Fishing Days (range names *FiSi*) available for the aggregate demand for fishing days within that row. This means that the total days fished by all vessels in a given Fleet (i) during a given season (m) can not exceed the limits assigned under the K-variable for that fleet and season combination. These values have been set to negative numbers so that when all possible fishing days are used up, the right hand side (RHS) in column HQ will show 0 fishing days remaining.

A	HM	HN	HO	HP	HQ	HR	HS
83				<=	0	E LIMITS E1--1	
84				<=	0	E1--2	
85				<=	0	E1--3	
86				<=	0	E2--1	
87				<=	0	E2--2	
88				<=	0	E2--3	
89				<=	0	E3--1	
90				<=	0	E3--2	
91				<=	0	E3--3	
92				<=	0	E4--1	
93				<=	0	E4--2	
94				<=	0	E4--3	
95	-49			<=	0	E5--1	
96		-95		<=	0	E5--2	
97			-129	<=	0	E5--3	

F. Problem Summary

On the basis of the previous parameter and constraint descriptions for the model's variables, this linear programming optimization problem can be stated as follows.

Maximize: $MR_{ijkm} - FC_{im}$

Subject to:

1) Fleet Size $> FLTO_i$ and $<= FLT_i$

2) Q_{-jk-} and $Q_{-j--} <= MSY$

3) $E_{i--m} <=$ fishing days/fleet/season

4) Max. Fish Days $(_{ijkm}) <= 83UPPER_{ijkm}$

The LP83 program maximizes fleetwide profit [sum of all marginal net revenues (MR_{ijkm}) less their fixed costs (FC_{im})] by determining the optimum size for a fleet operating within the most favorable (highest net income) environment (fishing situation) and the optimal number of fishing days (measure of effort) that should be assigned to that E-variable in order to produce the greatest net revenue for the industry (all fleets taken together).

The marginal net revenue (MR) produced by each E-variable ($_{ijkm}$) less its portion of the annual fixed costs (FC_{im}) is evaluated among those of all the other E-variables by the LP83 program to identify the E-variables with the greatest net revenue potential. Fishing days are then allocated to these higher income fishing situations subject to all of the limitations and restrictions specified in the model. For this model, these restraints include a minimum number of boats per fleet ($FLTO_i$) requirement that may result in some low income fishing situations (E-variables) being assigned fishing days. Fleet size (minimum and maximum number of boats allowed) is defined within the Bounds for the K-variables under range names 83LOWER and 83UPPER.

Other principal restrictions are limits on the amount of a species that can be harvested from each area (Q_{-jk-}); the annual maximum sustainable yield (MSY) for each species (Q_{-j--}) that can be taken from all areas combined; and the maximum number of fishing days available to each fleet in each season (E_{i--m}), based on the season's calendar days. Each E-variable has a ceiling on its assignable fishing days that is set within the Bounds section (range name 83UPPER).

IV. LP83 RESULTS FROM MODEL

After running the model, LP83 returns various solution values to defined sections of the spreadsheet. These defined areas have LP83 program range names. In this model, the following range names have been incorporated.

83VA (cells G40-HP40) = activity values.

a) number of fishing days assigned to each E-variable (fishing situation) in cells G40-GZ40;

b) number of boats included under each K-variable (vessels participating per fleet per season) in cells HA40-HO40; and

c) the fleetwide profit (maximized solution value) for the multifishery model in cell HP40.

83CA (cells HT60-HT97) = amount of limited resource used.

a) pounds of each species used per area (the Q-jk- rows);

b) total pounds of each species used (the Q-j-- rows); and

c) for the E constraints, it represents the number of available fishing days (per fleet per season) NOT utilized.

83CR (cells HU60-HU97) = the reduced cost value for each limited resource.

For convenience, the data area (E38-HP51) of the updated spreadsheet has been transposed into a vertical table [see Appendix A, Item 4].

Besides updating the spreadsheet with these solution values, LP83 also generates a detailed report that includes (when requested) a cost analysis and a margin analysis of the model's variables [see Appendix B].

The following are hypothetical results that test the functionality of the model and should NOT be directly applied to Hawaii's real-world commercial fishery.

In Season 1 (holiday) all available vessels in each fleet type fished. However, during Seasons 2 (summer) and 3 (winter), with one exception, only the minimum number of boats required to be included in each fleet participated in the model's solution (see the end of the Variable Activity section of the report

in Appendix B). Season 1 may be economically favored in this model because species market prices are usually higher during the holiday season.

Fleet 4 (large, multipurpose vessels) was the exception as it had all of its vessels fishing in every season. This indicates that Fleet 4 generated a profit in all seasons, whereas the other fleets may have been forced into the solution by the minimum boat requirement, even if they operated at a loss.

From the Constraints table of the report, it can be seen that all of the Species 1 (bottomfish) poundage was used up in each of the three areas (MHI, lower NWHI and upper NWHI) where fishing for bottomfish is feasible.

Species 2 (PMUS) was only harvested from Area 2 (lower NWHI) and, even then, not fully utilized (43% of the available poundage for this area). Overall, this harvest represents 27% of the annual maximum sustainable yield for the PMUS fishery (Q-2--).

Of the three areas where lobster (Species 3) are taken (lobster trapping is not feasible offshore - Area 4), none were harvested from Area 1 (MHI), 43% of the allowable pounds were removed from Area 2 (lower NWHI), and all of the resource poundage was utilized in Area 3 (upper NWHI). Since the lobster fishery annual limit (Q-3--) was reached, it is possible that more lobster fishing would have been allowed by LP83 in the under-utilized areas if the maximum sustainable yield were greater.

No one fished for Species 4 (aku and other small tunas), so the resource was untapped. A probable reason for this result was that the income generated (catch rate <u>times</u> the species market price, which was low) was not sufficient to offset the vessel costs for boats in under-utilized fleets (1,2,3,5), thereby enabling them to make a positive contribution to the fleetwide profit.

The allowable annual yield for Species 5 (ahi or large tunas) was completely utilized, but the harvest was not evenly distributed through all areas. Most of the fish (83%) were taken from Area 4 (offshore), followed by 14% from Area 1 (MHI). Only a small amount (3%) came from the lower NWHI (Area 2), and no ahi fishing took place in Area 3 (upper NWHI). If more of this resource had been available, there may have been larger harvests from Areas 1 and 2.

The combined number of fishing days assigned in the solution is 39,224 days (sum of all Activity values for the E-variables in the report). Since there are a total of 450 vessels participating in the solution, each vessel would fish an average of 87 days per year. According to the average boat costs and species' revenue generating capabilities estimated for this model, the profit calculated by LP83 for the multifishery industry is about $10.8 million dollars. This amounts to an average of $24,092 earned per vessel per year.

The approximate species and fleet category contributions to this $10.8 million fleetwide net revenue value are set forth below.

From each Species group:			Net Revenue
Species 1 (bottomfish)	-- 4.1%	=	$ 444,492
Species 2 (PMUS)	-- 0.4%	=	$ 43,365
Species 3 (lobster)	-- 15.2%	=	$1,647,872
Species 4 (aku)	-- 0%	=	$ 0
Species 5 (ahi)	-- 80.3%	=	$8,705,537

From each fleet group:			Net Revenue
Fleet 1 (trailered, small moored)	-- 11.9%	=	$1,290,111
Fleet 2 (medium moored)	-- 2.9%	=	$ 314,397
Fleet 3 (medium multipurpose)	-- 21.6%	=	$2,341,713
Fleet 4 (large multipurpose)	-- 51.8%	=	$5,615,776
Fleet 5 (catcher/processor)	-- 11.8%	=	$1,279,269

These percentages are derived from the report's Activity Solution table. The Activity value (assigned number of fishing days) is multiplied by its Cost value (Fleet revenue per fishing day) to give the revenue generated by that fishing situation. Revenues are then grouped by species and by fleets and summed to produce each group's total revenue. Since fixed costs have not been subtracted from the Cost values in the table, the total Fleetwide revenue at this point equals the sum of either the species' or fleet's total revenue figures ($18.5 million). Each species and fleet category revenue is then divided by $18.5 million to produce its percent contribution. Dollar contributions listed result from multiplying these percentages times the fleetwide profit given at the beginning of the table -- $10.8 million.

The distribution of fishing days among the E-variables indicates one possible answer as to how the Hawaii multifishery could most profitably spend its effort, based on the input data provided through this model to LP83. However, the Statistics section of the report (Appendix B) states that there may be alternative solutions. This means that other fishing day distribution patterns could generate the same fleetwide profit.

Besides profitability, vessel operators may have other reasons for determining how best to spend their fishing efforts. Real-world fishermen may place a higher priority on minimizing their risks and reducing uncertainty.

Fleet 1 (trailered or small, moored boats), using its maximum of 300 vessels, invested 36% of its annual effort fishing for bottomfish in Area 1 (MHI) during the summer. For the rest of the year, only half of the fleet (150 boats) participated. These vessels targeted Species 5 (ahi) exclusively in Area 1 (MHI) with approximately the same number of fishing days (32% of the annual effort)

used in the holiday period (Season 1) as in Season 3 (winter). Since Season 3 has three times as many calendar days as Season 1, the vessels fished more intensively during the holiday period. On average, each participating vessel drew 28 fishing days during the summer (when more boats were included in the fishery) compared to 48 and 50 fishing days (per boat) respectively in the holiday and winter seasons.

Fleet 2 (medium, moored vessels) spent half of its annual effort fishing for Species 2 (PMUS) in the summer months, and the other half targeting ahi (Species 5) during the holidays (Season 1). All harvesting centered around Area 2 (lower NWHI). The maximum number of vessels (50) participated in the holiday season ahi catch, while only half of the fleet (25 boats) fished during the summer for PMUS. The Fleet did not fish at all during the winter (Season 3). Boats participating during the holiday season had half as many fishing days (27), on average, as those taking part in the summer (56 fishing days per vessel). Due to the holiday season being considerably shorter, fishing effort in that period was somewhat more intensive.

Fleet 3 (medium, multipurpose boats) used all its vessels during the holiday period (Season 1) fishing principally for Species 5 (ahi) in Area 4 (offshore), and, to a very small extent, harvest bottomfish from Area 2 (lower NWHI). During the rest of the year, only the required minimum of 25 vessels fished. The Fleet's fishing effort was distributed as follows.

	Annual Fishing Effort
Holiday (Season 1):	
Species 5 (ahi) in Area 4 (offshore)	- 29.2%
Species 1 (bottomfish) in lower NWHI	- 1.7%
Summer (Season 2):	
Species 1 (bottomfish) in upper NWHI	- 6.1%
Species 2 (PMUS) in lower NWHI	- 26.3%
Winter (Season 3);	
Species 5 (ahi) in offshore	- 36.7%

Fleet 4 (large, multipurpose vessels) had all its vessels fishing in every season, mainly targeting Species 5 (ahi) in Area 4 (offshore). The only change in this fishing pattern occurred in the holiday period when a small effort (4% of the annual fishing days) was made to trap a few lobster (Species 3) from Area 3 (upper NWHI). The remainder of the holiday season was devoted to the ahi catch.

Fleet 5 (catcher/processor boats) fully employed its 5 vessels duing the holiday season, but worked with half the fleet (2.5 boats) the rest of the year. The catch consisted solely of lobster, most of which was taken from Area 3 (upper NWHI). A small amount of the summer harvest (7.2% of the annual effort) was from lower NWHI (Area 2).

It is important to reiterate that these results are hypothetical. They assist in identifying potential weaknesses in the model's assumptions and basic input data values. The LP83 report indicates economic trends, including the probable impacts of altering various aspects of the model.

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APPENDIX A

APPENDIX - ITEM A1: MULTIFISHERY SPREADSHEET (VALUES)

A	B	C	D	E	F	G	H	I	J
HCMULT1.WKS		** TITLE SECTION			HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1				
04-Jan-90									
4		** OPERATING ENVIRONMENT SECTION							
5									
6			FLEETS		BOATS =	MINI	MAXI		SPECIES
7			FLEET 1 = SM TRAILER/MOOR			150	300		SPECIES 1 = BOTTOMFISH
8			FLEET 2 = MED MOORED			25	50		SPECIES 2 = PMUS (MAHI,ONO)
9			FLEET 3 = MED MULTIPURPOSE			37.5	75		SPECIES 3 = LOBSTER
10			FLEET 4 = LGE MULTIPURPOSE			10	20		SPECIES 4 = AKU
11			FLEET 5 = CATCHER/PROCESSOR			2.5	5		SPECIES 5 = LARGE TUNA
12									
13									
14									
15					EXPECTED TOTAL POTENTIAL FISHING				
16					DAYS PER BOAT PER SEASON [FiSi]				
17					Holiday	Summer	Winter	Total [TFDi]	
18			FLEET 1 = SM TRAILER/MOOR		24	68	51	143	
19			FLEET 2 = MED MOORED		27	56	64	147	
20			FLEET 3 = MED MULTIPURPOSE		28	59	67	154	
21			FLEET 4 = LGE MULTIPURPOSE		50	101	137	288	
22			FLEET 5 = CATCHER/PROCESSOR		49	95	129	273	
23									
24									
25					ACTUAL FISHING DAYS (PER BOAT)				
26					Holiday	Summer	Winter		
27				Fleet 1-SM T/M	24	56	51		
28				Fleet 2-MED MR	27	56	0		
29				Fleet 3-M.MULT	28	59	67		
30				Fleet 4-L.MULT	50	101	137		
31				Fleet 5-CAT/PR	49	95	129		
32									
33									
34									
35		** LP83 DATA SECTION (Fishing Day Basis)							
36									
37				HCMULT1.WKS	Enter Date >	04-Jan-90			
38					VARIABLE LIST->	E1111	E1112	E1113	E1211
39				** ECONOMIC PARAMETERS					
40				** SOLUTION VALUES			8360		
41				* DAILY CATCH RATE (q)		48	75	45	40
42				* FISH PRICE (p)		$4.97	$2.48	$3.31	$2.81
43				* REVENUE (R)		$238.50	$186.33	$149.06	$113.40
44				* DAILY OPERATING COST (c)		$101.13	$101.13	$101.13	$101.13
45				* HANDLING COST (hc)		$23.85	$18.63	$14.91	$11.34
46				* CREW SHARE COST (cs)		$34.06	$19.97	$9.91	$0.28
47				* ANNUAL FIXED COST/VESSEL					
48				* CATCH PER Eijkm		0	627000	0	0
49			** OBJECTIVE FUNCTION - MAX FLEETWIDE PROFIT *******						
50				* MARGINAL REVENUE		$79.46	$46.59	$23.12	$0.65
51				* NET REVENUE BEFORE FC		$0	$389,530	$0	$0

A	B	C	D	E	F	G	H	I	J
52			** BOUNDS **********		Effort Level Bounds (Based on Calendar Constraints)				
53					Fishing Days				
54				* LOWER BOUNDS		0	0	0	0
55									
56				* UPPER BOUNDS		7200	20510	15158	7200
57									
58			** CONSTRAINTS **********						
59									
60				* Q LIMITS	Q-11-	48	75	45	
61					Q-12-				
62					Q-13-				
63					Q-1--	48	75	45	
64					Q-21-				40
65					Q-22-				
66					Q-23-				
67					Q-24-				
68					Q-2--				40
69					Q-31-				
70					Q-32-				
71					Q-33-				
72					Q-3--				
73					Q-41-				
74					Q-42-				
75					Q-43-				
76					Q-44-				
77					Q-4--				
78					Q-51-				
79					Q-52-				
80					Q-53-				
81					Q-54-				
82					Q-5--				
83				* E LIMITS	E1--1	1			1
84					E1--2		1		
85					E1--3			1	
86					E2--1				
87					E2--2				
88					E2--3				
89					E3--1				
90					E3--2				
91					E3--3				
92					E4--1				
93					E4--2				
94					E4--3				
95					E5--1				
96					E5--2				
97					E5--3				

A	K	L	M	N	O	P	Q	R	S
HCMULT1.WKS									
04-Jan-90									
4									
5									
6				FISHING AREAS					SEASONS
7			AREA 1 = MAIN HAWAIIAN ISLANDS (to 161)						HOLIDAY (Dec
8	NO)		AREA 2 = LOWER NWHI (161 - 170)						SUMMER (May
9			AREA 3 = UPPER NWHI (170 - 185)						WINTER (Feb
10			AREA 4 = OFFSHORE (>50 MILES)						Sept
11									
12									
13									
14									
15		TOTAL POTENTIAL OPERATING					AVERAGE (PER TRIP)		
16		DAYS PER SEASON [OFiSi]					OPERATING DAYS [ODii]		
17		Holiday	Summer	Winter			Holiday	Summer	Winter
18	SM T/M	60	120	180		SM T/M	2.0	1.7	2.6
19	MED MRD	60	120	180		MED MRD	7.7	9.0	8.8
20	MED MULT	60	120	180		MED MULT	15.0	17.2	17.1
21	LGE MULT	60	120	180		LGE MULT	46.0	54.4	45.0
22	CAT/PRO	60	120	180		CAT/PRO	54.0	66.6	55.4
23							Annual Average =		26.8
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38	E1212	E1213	E1311	E1313	E1411	E1412	E1413	E1511	E1512
39	---	---	---	---	---	---	---	---	---
40								7200	
41	63	38	20	19	40	63	38	144	225
42	$1.41	$1.88	$6.03	$4.02	$1.82	$0.91	$1.21	$2.64	$1.32
43	$88.59	$70.88	$121.56	$75.98	$72.60	$56.72	$45.38	$380.70	$297.42
44	$101.13	$101.13	$101.13	$101.13	$101.13	$101.13	$101.13	$101.13	$101.13
45	$8.86	$7.09	$12.16	$7.60	$7.26	$5.67	$4.54	$38.07	$29.74
46	($6.42)	($11.20)	$2.48	($9.83)	($10.74)	($15.03)	($18.09)	$72.45	$49.96
47									
48	0	0	0	0	0	0	0	1036800	
49									
50	($21.40)	($37.34)	$5.79	($32.75)	($35.79)	($50.08)	($60.29)	$169.05	$116.58
51	$0	$0	$0	$0	$0	$0	$0	$1,217,151	$0

A	S	T	U	V	W	X	Y	Z	AA	AB	AC
HCMULT1.WKS											
04-Jan-90											
4											
5					CALENDAR DAYS PER				FISHING DAYS PER TRIP		
6	SEASONS				SEASON [SEAi]				(ANNUAL AVERAGE) [AFDFi]		
7	HOLIDAY (Dec-Jan) = 1				Holiday	60			SM T/M	0.8	
8	SUMMER (May-Aug) = 2				Summer	120			MED MRD	3.5	
9	WINTER (Feb-Apr = 3				Winter	180			MED MULT	7	
10	Sept-Nov)								LGE MULT	38	
11									CAT/PRO	44	
12											
13											
14											
15				AVERAGE (PER TRIP)					AVERAGE (PER TRIP)		
16				TURN-AROUND DAYS [TDii]					FISHING DAYS PER SEASON [FDii]		
17				Holiday	Summer	Winter			Holiday	Summer	Winter
18			SM T/M	0.9	0.5	1.5		SM T/M	0.80	0.96	0.72
19			MED MRD	2	3.2	3.2		MED MRD	3.50	4.20	3.15
20			MED MULT	3	5	5		MED MULT	7.00	8.40	6.30
21			LGE MULT	3	5	5		LGE MULT	38.00	45.60	34.20
22			CAT/PRO	5	10	10		CAT/PRO	44.00	52.80	39.60
23								RATE =	1	1.2	0.9
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											

38	E1512	E1513	E2111	E2112	E2113	E2121	E2122	E2123	E2211	E2212
39										
40		7579								
41	225	135	70	106	53	106	158	79	65	97
42	$1.32	$1.76	$4.97	$2.48	$3.31	$4.97	$2.48	$3.31	$3.38	$1.69
43	$297.42	$237.94	$349.80	$262.35	$174.90	$524.70	$393.53	$262.35	$218.70	$164.03
44	$101.13	$101.13	$161.81	$161.81	$161.81	$188.06	$188.06	$188.06	$161.81	$161.81
45	$29.74	$23.79	$34.98	$26.24	$17.49	$52.47	$39.35	$26.24	$21.87	$16.40
46	$49.96	$33.90	$61.20	$29.72	($1.76)	$113.67	$66.45	$19.22	$14.01	($5.68)
47										
48	0	1023158	0	0	0	0	0	0	0	0
49										
50	$116.58	$79.11	$91.81	$44.58	($4.40)	$170.50	$99.67	$28.83	$21.01	($14.19)
51	$0	$599,559	$0	$0	$0	$0	$0	$0	$0	$0

A	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
HCMULT1.WKS											
04-Jan-90											
4											
5	AVERAGE RUNNING DAYS IN			AVERAGE RUNNING DAYS BY					POTENTIAL TRIPS (PER BOAT) PER SEASON [PTii]		
6	AREA PER TRIP	[ARDAi]		FLEET PER TRIP	[ARDFi]				Holiday	Summer	Winter
7	MHI	0.3		SM T/M	0.3			SM T/M	30	71	70
8	LOW NWHI	4		MED MRD	2.2			MED MRD	8	13	20
9	UP NWHI	8		MED MULT	5			MED MULT	4	7	11
10	OFFSHORE	3		LGE MULT	5			LGE MULT	1	2	4
11				CAT/PRO	5			CAT/PRO	1	2	3
12											
13											
14											
15		AVERAGE (PER TRIP) RUNNING DAYS [RDii]							ACTUAL TRIPS (PER BOAT) PER SEASON		
16											
17		Holiday	Summer	Winter					Holiday	Summer	Winter
18	SM T/M	0.30	0.23	0.35				SM T/M	30	58	70
19	MED MRD	2.15	1.61	2.47				MED MRD	8	13	0
20	MED MULT	5.00	3.75	5.75				MED MULT	4	7	11
21	LGE MULT	5.00	3.75	5.75				LGE MULT	1	2	4
22	CAT/PRO	5.00	3.75	5.75				CAT/PRO	1	2	3
23	RATE =	1	0.75	1.15							
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											

	E2222	E2223	E2311	E2313	E2321	E2322	E2323	E2411	E2412	E2413	E2421
38											
39											
40	1398										
41	146	73	34	25	67	101	50	100	150	75	100
42	$1.69	$2.25	$6.03	$4.02	$6.03	$3.01	$4.02	$1.65	$0.83	$1.10	$1.65
43	$246.04	$164.02	$202.61	$101.30	$405.22	$303.91	$202.61	$165.00	$123.75	$82.50	$165.00
44	$188.06	$188.06	$161.81	$161.81	$188.06	$188.06	$188.06	$161.81	$161.81	$161.81	$188.06
45	$24.60	$16.40	$20.26	$10.13	$40.52	$30.39	$20.26	$16.50	$12.38	$8.25	$16.50
46	$13.35	($16.17)	$8.21	($28.25)	$70.65	$34.18	($2.28)	($5.32)	($20.17)	($35.02)	($15.82)
47											
48	203837	0	0	0	0	0	0	0	0	0	0
49											
50	$20.02	($40.44)	$12.32	($70.64)	$105.98	$51.28	($5.71)	($13.31)	($50.44)	($87.56)	($39.56)
51	$27,996	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

A	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA
HCMULT1.WKS										
04-Jan-90										
4										
5	ANNUAL FIXED COSTS					PREMIUM PRICE RATIO BY FLEET/SPECIES [PPii]				
6	PER VESSEL [FCVi]					Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7	SM T/M	$6,800			SM T/M-Flt 1	1.25	1.25	1.00	1.10	0.75
8	MED MRD	$20,000			MED MR-Flt 2	1.25	1.50	1.00	1.00	0.75
9	MED MULT	$50,000			M.MULT-Flt 3	1.00	1.00	1.00	1.00	1.25
10	LGE MULT	$130,000			L.MULT-Flt 4	0.75	0.75	1.00	0.70	1.00
11	CAT/PRO	$380,000			CAT/PR-Flt 5	0.50	0.50	1.00	0.50	0.50
12					Average Price [APSi]	$2.65	$1.50	$4.02	$1.10	$2.35
13										
14										
15	AVERAGE (PER DAY)									
16	OPERATING COSTS [OCVi]					AREA COST			SEASON PRICE	
17						RATIO [CRAi]			RATIO [PRSi]	
18	SM T/M	$100			Ar 1- MHI	1.01			SEAH =	1.50
19	MED MRD	$160			Ar 2-Lw NWHI	1.18			SEAS =	0.75
20	MED MULT	$840			Ar 3-Up NWHI	1.43			SEAW =	1.00
21	LGE MULT	$720			Ar 4-OffShor	1.13				
22	CAT/PRO	$1,212								
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										

38	E2511	E2512	E2513	E2521	E2522	E2523	E3111	E3112	E3113	E3121
39	---	---	---	---	---	---	---	---	---	---
40				1373						116
41	272	408	204	340	510	255	727	909	618	1091
42	$2.64	$1.32	$1.76	$2.64	$1.32	$1.76	$3.98	$1.99	$2.65	$3.98
43	$719.10	$539.33	$359.55	$898.88	$674.16	$449.44	$2,890.62	$1,806.64	$1,638.02	$4,335.93
44	$161.81	$161.81	$161.81	$188.06	$188.06	$188.06	$849.51	$849.51	$849.51	$987.31
45	$71.91	$53.93	$35.96	$89.89	$67.42	$44.94	$289.06	$180.66	$163.80	$433.59
46	$194.15	$129.43	$64.71	$248.37	$167.47	$86.57	$823.46	$364.94	$293.61	$1,370.06
47										
48	0	0	0	466667	0	0	0	0	0	126000
49										
50	$291.23	$194.15	$97.07	$372.56	$251.21	$129.86	$928.59	$411.53	$331.10	$1,544.96
51	$0	$0	$0	$511,353	$0	$0	$0	$0	$0	$178,461

A	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM
HCMULT1.WKS											
04-Jan-90											
4											
5		CATCH RATIO FLEET/SEASON [qFil]					AVERAGE CATCH RATE (q) FLEET/SPECIES [qFiSi]				
6		Holiday	Summer	Winter			Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7	SM T/M	0.80	1.25	0.75		SM T/M	75	63	42	50	225
8	MED MRD	1.00	1.50	0.75		MED MRD	88	81	56	100	340
9	MED MULT	1.00	1.25	0.85		MED MULT	909	682	385	500	682
10	LGE MULT	1.00	1.25	0.85		LGE MULT	709	682	708	1500	1364
11	CAT/PRO	1.00	1.10	0.90		CAT/PRO	682	682	1185	750	1364
12											
13											
14											
15											
16		CREW SHARES [CSHi]					SPECIES POUNDAGE LIMITS (Q) BY AREA				
17		(% of boat revenue)					Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
18		SM T/M	0.30			Ar 1- MHI	627,000	4,687,500	12,500	15,000,000	15,000,000
19		MED MRD	0.40			Ar 2-Lw NWHI	126,000	4,687,500	656,250	15,000,000	15,000,000
20		MED MULT	0.47			Ar 3-Up NWHI	474,000	4,687,500	1,218,750	15,000,000	15,000,000
21		LGE MULT	0.36			Ar 4-OffShor	0	7,500,000	0	15,000,000	15,000,000
22		CAT/PRO	0.40			TOTAL LBS	1,227,000	7,500,000	1,500,000	15,000,000	15,000,000
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											

38	E3123	E3131	E3132	E3133	E3211	E3212	E3213	E3221	E3222	E3223	E3231
39	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
40			417						1787		
41	927	909	1136	773	546	682	464	818	1023	696	818
42	$2.65	$3.98	$1.99	$2.65	$2.25	$1.13	$1.50	$2.25	$1.13	$1.50	$2.25
43	$2,457.03	$3,613.28	$2,258.30	$2,047.52	$1,227.60	$767.25	$695.64	$1,841.40	$1,150.88	$1,043.46	$1,841.40
44	$987.31	$1,197.28	$1,197.28	$1,197.28	$849.51	$849.51	$849.51	$987.31	$987.31	$987.31	$1,197.28
45	$245.70	$361.33	$225.83	$204.75	$122.76	$76.73	$69.56	$184.14	$115.09	$104.35	$184.14
46	$575.29	$965.70	$392.54	$303.38	$120.01	($74.72)	($105.01)	$314.88	$22.78	($22.65)	$216.19
47											
48	0	0	474000	0	0	0	0	0	1828019	0	0
49											
50	$648.73	$1,088.98	$442.65	$342.11	$135.33	($158.98)	($223.43)	$355.07	$25.69	($48.20)	$243.79
51	$0	$0	$184,657	$0	$0	$0	$0	$0	$45,911	$0	$0

A	BN	BO	BP	BQ	BR	BS	BT	BU
HCMULT1.WKS								
04-Jan-90								
4								
5				CATCH (q) RATIO AREA/SPECIES [qAiSi]				
6			Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI	
7		Ar 1- MHI	0.8	0.8	0.6	1.0	0.8	
8		Ar 2-Lw NWHI	1.2	1.2	1.2	1.0	1.0	
9		Ar 3-Up NWHI	1.0	1.2	1.4	1.0	1.0	
10		Ar 4-OffShor	0.0	1.0	0.0	1.0	1.2	
11								
12								
13								
14								
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32								
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34								
35								
36								
37								
38	E3232	E3233	E3241	E3242	E3243	E3311	E3313	E3321
39	---	---	---	---	---	---	---	---
40								
41	1023	696	682	853	580	231	196	462
42	$1.13	$1.50	$2.25	$1.13	$1.50	$6.03	$4.02	$6.03
43	$1,150.88	$1,043.46	$1,534.50	$959.06	$869.55	$1,392.93	$789.33	$2,785.86
44	$1,197.28	$1,197.28	$945.84	$945.84	$945.84	$849.51	$849.51	$987.31
45	$115.09	$104.35	$153.45	$95.91	$86.96	$139.29	$78.93	$278.59
46	($75.90)	($121.34)	$204.55	($38.86)	($76.73)	$189.94	($65.38)	$714.38
47								
48	0	0	0	0	0	0	0	0
49								
50	($161.49)	($258.16)	$230.66	($82.69)	($163.25)	$214.19	($139.11)	$805.58
51	$0	$0	$0	$0	$0	$0	$0	$0

A	GX	GY	GZ	HA	HB	HC	HD	HE	HF
37									
38	E5541	E5542	E5543	K1--1	K1--2	K1--3	K2--1	K2--2	K2--3
39									
40				300	150	150	50	25	25
41	1637	1800	1473						
42	$1.76	$0.88	$1.18						
43	$2,884.86	$1,586.67	$1,730.92						
44	$1,364.72	$1,364.72	$1,364.72						
45	$288.49	$158.67	$173.09						
46	$492.66	$25.32	$77.24						
47				$1,142	$3,253	$2,404	$3,719	$7,575	$8,706
48	0	0	0						
49									
50	$739.00	$37.97	$115.87	($1,142)	($3,253)	($2,404)	($3,719)	($7,575)	($8,706)
51	$0	$0	$0	($342,631)	($488,020)	($360,664)	($185,931)	($189,386)	($217,648)
52									
53									
54	0	0	0	150	150	150	25	25	25
55									
56	244	476	644	300	300	300	50	50	50
57									
58									
59									
60									
61									
62									
63									
64									
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71									
72									
73									
74									
75									
76									
77									
78									
79									
80									
81	1637	1800	1473						
82	1637	1800	1473						
83				-24					
84					-68				
85						-51			
86							-27		
87								-56	
88									-64
89									

A	HG	HH	HI	HJ	HK	HL	HM	HN	HO
37									
38	K3--1	K3--2	K3--3	K4--1	K4--2	K4--3	K5--1	K5--2	K5--3
39									
40	75	37.5	37.5	20	20	20	5	2.5	2.5
41									
42									
43									
44									
45									
46									
47	$9,133	$19,172	$21,695	$22,436	$45,573	$61,991	$68,081	$132,582	$179,336
48									
49									
50	($9,133)	($19,172)	($21,695)	($22,436)	($45,573)	($61,991)	($68,081)	($132,582)	($179,336)
51	($684,995)	($718,945)	($813,557)	($448,713)	($911,461)	($1,239,826)	($340,407)	($331,456)	($448,341)
52									
53									
54	37.5	37.5	37.5	10	10	10	2.5	2.5	2.5
55									
56	75	75	75	20	20	20	5	5	5
57									
58									
59									
60									
61									
62									
63									
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86									
87									
88									
89	-28								
90		-59							
91			-67						
92				-50					
93					-101				
94						-137			
95							-49		
96								-95	
97									-129

A	HP	HQ		HR	HS	HT	HU	HV
37								
38	NET PROFIT	LIMITS AVAIL		LIMIT PARMS		LIMITS USED	LIM RE COST	
39	---	---	---	---	---	---	---	---
40	10841266							
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60		<=	627,000	Q LIMITS	Q-11-	627,000	0.62	
61		<=	126,000		Q-12-	126,000	0.70	
62		<=	474,000		Q-13-	474,000	0.37	
63		<=	1,227,000		Q-1--	1,227,000		
64		<=	4,687,500		Q-21-			
65		<=	4,687,500		Q-22-	2,031,856		
66		<=	4,687,500		Q-23-			
67		<=	7,500,000		Q-24-			
68		<=	7,500,000		Q-2--	2,031,856		
69		<=	12,500		Q-31-			
70		<=	656,250		Q-32-	281,250		
71		<=	1,218,750		Q-33-	1,218,750	0.01	
72		<=	1,500,000		Q-3--	1,500,000	0.86	
73		<=	15,000,000		Q-41-			
74		<=	15,000,000		Q-42-			
75		<=	15,000,000		Q-43-			
76		<=	15,000,000		Q-44-			
77		<=	15,000,000		Q-4--			
78		<=	15,000,000		Q-51-	2,059,958		
79		<=	15,000,000		Q-52-	466,667		
80		<=	15,000,000		Q-53-			
81		<=	15,000,000		Q-54-	12,473,375		
82		<=	15,000,000		Q-5--	15,000,000	0.54	
83		<=	0	E LIMITS	E1--1		49.64	
84		<=	0		E1--2	-1895		
85		<=	0		E1--3		6.16	
86		<=	0		E2--1		188.83	
87		<=	0		E2--2		20.02	
88		<=	0		E2--3	-1607		
89		<=	0		E3--1		776.56	
90		<=	0		E3--2		25.69	
91		<=	0		E3--3		97.52	
92		<=	0		E4--1		1920.03	
93		<=	0		E4--2		452.65	
94		<=	0		E4--3		612.57	
95		<=	0		E5--1		2916.26	
96		<=	0		E5--2		340.42	
97		<=	0		E5--3		900.37	

APPENDIX - ITEM A2: MULTIFISHERY SPREADSHEET (EQUATIONS)

	A	B	C	D	E	F	G	H
	HCMULT1.WKS		** TITLE SECTION			HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1		
	@NOW							
4			** OPERATING ENVIRONMENT SECTION					
5								
6				FLEETS		BOATS = MINI	MAXI	
7				FLEET 1 = SM TRAILER/MOOR		+FLT1/2	300	
8				FLEET 2 = MED MOORED		+FLT2/2	50	
9				FLEET 3 = MED MULTIPURPOSE		+FLT3/2	75	
10				FLEET 4 = LGE MULTIPURPOSE		+FLT4/2	20	
11				FLEET 5 = CATCHER/PROCESSOR		+FLT5/2	5	
12								
13								
14								
15						EXPECTED TOTAL POTENTIAL FISHING		
16						DAYS PER BOAT PER SEASON [FiSi]		
17						Holiday	Summer	Winter
18				FLEET 1 = SM TRAILER/MOOR		+PT1H*FD1H	+PT1S*FD1S	+PT1W*FD1W
19				FLEET 2 = MED MOORED		+PT2H*FD2H	+PT2S*FD2S	+PT2W*FD2W
20				FLEET 3 = MED MULTIPURPOSE		+PT3H*FD3H	+PT3S*FD3S	+PT3W*FD3W
21				FLEET 4 = LGE MULTIPURPOSE		+PT4H*FD4H	+PT4S*FD4S	+PT4W*FD4W
22				FLEET 5 = CATCHER/PROCESSOR		+PT5H*FD5H	+PT5S*FD5S	+PT5W*FD5W
23								
24								
25						ACTUAL FISHING DAYS (PER BOAT)		
26						Holiday	Summer	Winter
27					Fleet 1-SM T/M	(G40+J40+M40+O	(H40+K40+P4	(I40+L40+N40+Q40+T40)/HC40
28					Fleet 2-MED MR	(U40+X40+AA40+	(V40+Y40+AB	(W40+Z40+AC40+AF40+AH40+AK40+
29					Fleet 3-M.MULT	(AX40+BA40+BD4	(AY40+BB40+	(AZ40+BC40+BF40+BI40+BL40+BO
30					Fleet 4-L.MULT	(CY40+DB40+DE4	(CZ40+DC40+	(DA40+DD40+DG40+DJ40+DM40+DP4
31					Fleet 5-CAT/PR	(EZ40+FC40+FF4	(FA40+FD40+	(FB40+FE40+FH40+FK40+FN40+FQ4
32								
33								
34								
35			** LP83 DATA SECTION (Fishing Day Basis)					
36								
37				HCMULT1.WKS Enter Date > @NOW				
38					VARIABLE LIST->	E1111		E1112
39				** ECONOMIC PARAMETERS		----------		
40				** SOLUTION VALUES				8360
41				* DAILY CATCH RATE (q)		+$QF1H*$QF1	+$QF1S*$QF1S1*$QA1S1	
42				* FISH PRICE (p)		+$PP11*$APS	+$PP11*$APS1*$PRS2	
43				* REVENUE (R)		+G41*G42	+H41*H42	
44				* DAILY OPERATING COST (c)		+$OCV1*$CRA	+$OCV1*$CRA1	
45				* HANDLING COST (hc)		(G41*G42)*0	(H41*H42)*0.1	
46				* CREW SHARE COST (cs)		((G41*G42)-	((H41*H42)-(H44+H45))*$CSH1	
47				* ANNUAL FIXED COST/VESSEL				
48				* CATCH PER Eijkm		+G40*G41	+H40*H41	
49				** OBJECTIVE FUNCTION - MAX FLEETWIDE PROFIT *******				
50				* MARGINAL REVENUE		((G41*G42)-	((H41*H42)-(H44+H45+(@IF(H46>=0,H46,0)))	
51				* NET REVENUE BEFORE FC		+G40*G50	+H40*H50	

A	B	C	D	E	F	G	H
52		** BOUNDS **********			Effort Level Bounds (Based on Calendar Constraints)		
53					Fishing Days		
54			* LOWER BOUNDS			0	0
55							
56			* UPPER BOUNDS			+$FLT1*$F1S1	+$FLT1*$F1S2
57							
58		** CONSTRAINTS **********					
59							
60			* Q LIMITS	Q-11-		+G$41	+H$41
61				Q-12-			
62				Q-13-			
63				Q-1--		@SUM(G60..G62)	@SUM(H60..H62)
64				Q-21-			
65				Q-22-			
66				Q-23-			
67				Q-24-			
68				Q-2--			
69				Q-31-			
70				Q-32-			
71				Q-33-			
72				Q-3--			
73				Q-41-			
74				Q-42-			
75				Q-43-			
76				Q-44-			
77				Q-4--			
78				Q-51-			
79				Q-52-			
80				Q-53-			
81				Q-54-			
82				Q-5--			
83			* E LIMITS	E1--1		1	
84				E1--2			1
85				E1--3			
86				E2--1			
87				E2--2			
88				E2--3			
89				E3--1			
90				E3--2			
91				E3--3			
92				E4--1			
93				E4--2			
94				E4--3			
95				E5--1			
96				E5--2			
97				E5--3			

	A	I	J	K	L	M	N	O
	HCMULT1.WKS							
	@NOW							
4								
5								
6		SPECIES					FISHING AREAS	
7		SPECIES 1 = BOTTOMFISH				AREA 1 = MAIN HAWAIIAN ISLANDS (to 161)		
8		SPECIES 2 = PMUS (MAHI,ONO)				AREA 2 = LOWER NWHI (161 - 170)		
9		SPECIES 3 = LOBSTER				AREA 3 = UPPER NWHI (170 - 185)		
10		SPECIES 4 = AKU				AREA 4 = OFFSHORE (>50 MILES)		
11		SPECIES 5 = LARGE TUNA						
12								
13								
14								
15					TOTAL POTENTIAL OPERATING			
16					DAYS PER SEASON [OFiSi]			
17		Total [TFDi]			Holiday	Summer	Winter	
18		(F1S1+F1S2+F1S3)		SM T/M	+PT1H*OD1H	+PT1S*OD1S	+PT1W*OD1W	
19		(F2S1+F2S2+F2S3)		MED MRD	+PT2H*OD2H	+PT2S*OD2S	+PT2W*OD2W	
20		(F3S1+F3S2+F3S3)		MED MULT	+PT3H*OD3H	+PT3S*OD3S	+PT3W*OD3W	
21		(F4S1+F4S2+F4S3)		LGE MULT	+PT4H*OD4H	+PT4S*OD4S	+PT4W*OD4W	
22		(F5S1+F5S2+F5S3)		CAT/PRO	+PT5H*OD5H	+PT5S*OD5S	+PT5W*OD5W	
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38		E1113	E1211	E1212	E1213	E1311	E1313	E1411
39		---	---	---	---	---	---	---
40								
41		+$QF1W*$QF1S1*$Q	+$QF1H*$QF1	+$QF1S*$QF1	+$QF1W*$QF1	+$QF1H*$QF1	+$QF1W*$QF1	+$QF1H*$QF1
42		+$PP11*$APS1*$PR	+$PP12*$APS	+$PP12*$APS	+$PP12*$APS	+$PP13*$APS	+$PP13*$APS	+$PP14*$APS
43		+I41*I42	+J41*J42	+K41*K42	+L41*L42	+M41*M42	+N41*N42	+O41*O42
44		+$OCV1*$CRA1	+$OCV1*$CRA	+$OCV1*$CRA	+$OCV1*$CRA	+$OCV1*$CRA	+$OCV1*$CRA	+$OCV1*$CRA
45		(I41*I42)*0.1	(J41*J42)*0	(K41*K42)*0	(L41*L42)*0	(M41*M42)*0	(N41*N42)*0	(O41*O42)*0
46		((I41*I42)-(I44+	((J41*J42)-	((K41*K42)-	((L41*L42)-	((M41*M42)-	((N41*N42)-	((O41*O42)-
47								
48		+I40*I41	+J40*J41	+K40*K41	+L40*L41	+M40*M41	+N40*N41	+O40*O41
49								
50		(I41*I42)-(I44+I	(J41*J42)-(	(K41*K42)-(	(L41*L42)-(	(M41*M42)-(	(N41*N42)-(	(O41*O42)-(
51		+I40*I50	+J40*J50	+K40*K50	+L40*L50	+M40*M50	+N40*N50	+O40*O50

```
     A          P              Q              R              S          T        U        V        W        X
HCMULT1.WKS
@NOW
     4
     5                                                                                  CALENDAR DAYS PER
     6                                                      SEASONS                       SEASON [SEAl]
     7                                              HOLIDAY (Dec-Jan) = 1               Holiday        60
     8                                              SUMMER  (May-Aug) = 2               Summer        120
     9                                              WINTER  (Feb-Apr  = 3               Winter        180
    10                                                      Sept-Nov)
    11
    12
    13
    14
    15                 AVERAGE (PER TRIP)                                                   AVERAGE (PER TRIP)
    16                OPERATING DAYS [ODii]                                              TURN-AROUND DAYS [TDii]
    17                    Holiday          Summer          Winter                         Holiday    Summer    Winter
    18      SM T/M  +FD1H+RD1H+TD1H +FD1S+RD1S+TD1S +FD1W+RD1W+TD1W          SM T/M        0.9        0.5       1.5
    19     MED MRD  +FD2H+RD2H+TD2H +FD2S+RD2S+TD2S +FD2W+RD2W+TD2W         MED MRD          2        3.2       3.2
    20    MED MULT  +FD3H+RD3H+TD3H +FD3S+RD3S+TD3S +FD3W+RD3W+TD3W        MED MULT          3          5         5
    21    LGE MULT  +FD4H+RD4H+TD4H +FD4S+RD4S+TD4S +FD4W+RD4W+TD4W        LGE MULT          3          5         5
    22     CAT/PRO  +FD5H+RD5H+TD5H +FD5S+RD5S+TD5S +FD5W+RD5W+TD5W         CAT/PRO          5         10        10
    23            Annual Average =                 @AVG(Q18..S22)
    24
    25
    26
    27
    28
    29
    30
    31
    32
    33
    34
    35
    36
    37
    38      E1412          E1413          E1511          E1512      E1513      E2111      E2112      E2113
    39 ----------------------------------------------------------------------------------------------------
    40                                        7200                    7579
    41 +$QF1S*$QF1 +$QF1W*$QF1S4*$ +$QF1H*$QF1S5*$ +$QF1S*$QF1S5*$ +$QF1W*$QF1 +$QF2H*$QF2 +$QF2S*$QF2 +$QF2W*$QF2
    42 +$PP14*$APS +$PP14*$APS4*$P +$PP15*$APS5*$P +$PP15*$APS5*$P +$PP15*$APS +$PP21*$APS +$PP21*$APS +$PP21*$APS
    43 +P41*P42    +Q41*Q42        +R41*R42        +S41*S42        +T41*T42    +U41*U42    +V41*V42    +W41*W42
    44 +$OCV1*$CRA +$OCV1*$CRA1    +$OCV1*$CRA1    +$OCV1*$CRA1    +$OCV1*$CRA +$OCV2*$CRA +$OCV2*$CRA +$OCV2*$CRA
    45 (P41*P42)*0 (Q41*Q42)*0.1   (R41*R42)*0.1   (S41*S42)*0.1   (T41*T42)*0 (U41*U42)*0 (V41*V42)*0 (W41*W42)*0
    46 ((P41*P42)- ((Q41*Q42)-(Q44 ((R41*R42)-(R44 ((S41*S42)-(S44 ((T41*T42)- ((U41*U42)- ((V41*V42)- ((W41*W42)-
       47
    48 +P40*P41    +Q40*Q41        +R40*R41        +S40*S41        +T40*T41    +U40*U41    +V40*V41    +W40*W41
    49
    50 (P41*P42)-( (Q41*Q42)-(Q44+ (R41*R42)-(R44+ (S41*S42)-(S44+ (T41*T42)-( (U41*U42)-( (V41*V42)-( (W41*W42)-(
    51 +P40*P50    +Q40*Q50        +R40*R50        +S40*S50        +T40*T50    +U40*U50    +V40*V50    +W40*W50
```

	A	Y	Z	AA	AB	AC	AD
HCMULT1.WKS							
@NOW							
4							
5				FISHING DAYS PER TRIP			
6				(ANNUAL AVERAGE) [AFDFi]			
7				SM T/M	0.8		
8				MED MRD	3.5		
9				MED MULT	7		
10				LGE MULT	38		
11				CAT/PRO	44		
12							
13							
14							
15				AVERAGE (PER TRIP)			
16				FISHING DAYS PER SEASON [FDii]			
17				Holiday	Summer	Winter	
18			SM T/M	+AFDF1*AA23	+AFDF1*AB23	+AFDF1*AC23	
19			MED MRD	+AFDF2*AA23	+AFDF2*AB23	+AFDF2*AC23	
20			MED MULT	+AFDF3*AA23	+AFDF3*AB23	+AFDF3*AC23	
21			LGE MULT	+AFDF4*AA23	+AFDF4*AB23	+AFDF4*AC23	
22			CAT/PRO	+AFDF5*AA23	+AFDF5*AB23	+AFDF5*AC23	
23			RATE =	1	1.2	0.9	
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							

	E2122	E2123	E2211	E2212	E2213	E2221
38						
39						
40						
41	+$QF2S*$QF2	+$QF2W*$QF2	+$QF2H*$QF2	+$QF2S*$QF2	+$QF2W*$QF2	+$QF2H*$QF2
42	+$PP21*$APS	+$PP21*$APS	+$PP22*$APS	+$PP22*$APS	+$PP22*$APS	+$PP22*$APS
43	+Y41*Y42	+Z41*Z42	+AA41*AA42	+AB41*AB42	+AC41*AC42	+AD41*AD42
44	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA
45	(Y41*Y42)*0	(Z41*Z42)*0	(AA41*AA42)	(AB41*AB42)	(AC41*AC42)	(AD41*AD42)
46	((Y41*Y42)-	((Z41*Z42)-	((AA41*AA42	((AB41*AB42	((AC41*AC42	((AD41*AD42
47						
48	+Y40*Y41	+Z40*Z41	+AA40*AA41	+AB40*AB41	+AC40*AC41	+AD40*AD41
49						
50	(Y41*Y42)-(	(Z41*Z42)-(	(AA41*AA42)	(AB41*AB42)	(AC41*AC42)	(AD41*AD42)
51	+Y40*Y50	+Z40*Z50	+AA40*AA50	+AB40*AB50	+AC40*AC50	+AD40*AD50

A	AD	AE	AF	AG	AH	AI	AJ
HCMULT1.WKS							
@NOW							
4							
5			AVERAGE RUNNING DAYS IN		AVERAGE RUNNING DAYS BY		
6			AREA PER TRIP [ARDAi]		FLEET PER TRIP [ARDFi]		
7			MHI	0.3	SM T/M	@AVG(ARDA1)	
8			LOW NWHI	4	MED MRD	@AVG(AF7..AF8)	
9			UP NWHI	8	MED MULT	@AVG(AF8..AF10)	
10			OFFSHORE	3	LGE MULT	@AVG(AF8..AF10)	
11					CAT/PRO	@AVG(AF8..AF10)	
12							
13							
14							
15				AVERAGE (PER TRIP)			
16				RUNNING DAYS [RDii]			
17				Holiday	Summer	Winter	
18			SM T/M	+ARDF1*AF23	+ARDF1*AG23	+ARDF1*AH23	
19			MED MRD	+ARDF2*AF23	+ARDF2*AG23	+ARDF2*AH23	
20			MED MULT	+ARDF3*AF23	+ARDF3*AG23	+ARDF3*AH23	
21			LGE MULT	+ARDF4*AF23	+ARDF4*AG23	+ARDF4*AH23	
22			CAT/PRO	+ARDF5*AF23	+ARDF5*AG23	+ARDF5*AH23	
23			RATE =	1	0.75	1.15	
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							

	E2221	E2222	E2223	E2311	E2313	E2321	E2322
38							
39							
40		1398					
41	+$QF2H*$QF2	+$QF2S*$QF2	+$QF2W*$QF2	+$QF2H*$QF2	+$QF2W*$QF2	+$QF2H*$QF2S3*$	+$QF2S*$QF2
42	+$PP22*$APS	+$PP22*$APS	+$PP22*$APS	+$PP23*$APS	+$PP23*$APS	+$PP23*$APS3*$P	+$PP23*$APS
43	+AD41*AD42	+AE41*AE42	+AF41*AF42	+AG41*AG42	+AH41*AH42	+AI41*AI42	+AJ41*AJ42
44	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA2	+$OCV2*$CRA
45	(AD41*AD42)	(AE41*AE42)	(AF41*AF42)	(AG41*AG42)	(AH41*AH42)	(AI41*AI42)*0.1	(AJ41*AJ42)
46	((AD41*AD42	((AE41*AE42	((AF41*AF42	((AG41*AG42	((AH41*AH42	((AI41*AI42)-(A	((AJ41*AJ42
47							
48	+AD40*AD41	+AE40*AE41	+AF40*AF41	+AG40*AG41	+AH40*AH41	+AI40*AI41	+AJ40*AJ41
49							
50	(AD41*AD42)	(AE41*AE42)	(AF41*AF42)	(AG41*AG42)	(AH41*AH42)	(AI41*AI42)-(AI	(AJ41*AJ42)
51	+AD40*AD50	+AE40*AE50	+AF40*AF50	+AG40*AG50	+AH40*AH50	+AI40*AI50	+AJ40*AJ50

	A	AK	AL	AM	AN	AO	AP	AQ	AR	AS
	HCMULT1.WKS									
	@NOW									
4				POTENTIAL TRIPS (PER BOAT)						
5				PER SEASON [PTii]					ANNUAL FIXED COSTS	
6				Holiday	Summer	Winter			PER VESSEL	[FCVi]
7			SM T/M	+SEAH/OD1H	+SEAS/OD1S	+SEAW/OD1W			SM T/M	6800
8			MED MRD	+SEAH/OD2H	+SEAS/OD2S	+SEAW/OD2W			MED MRD	20000
9			MED MULT	+SEAH/OD3H	+SEAS/OD3S	+SEAW/OD3W			MED MULT	50000
10			LGE MULT	+SEAH/OD4H	+SEAS/OD4S	+SEAW/OD4W			LGE MULT	130000
11			CAT/PRO	+SEAH/OD5H	+SEAS/OD5S	+SEAW/OD5W			CAT/PRO	380000
12										
13										
14										
15				ACTUAL TRIPS (PER BOAT)					AVERAGE (PER DAY)	
16				PER SEASON					OPERATING COSTS	[OCVi
17				Holiday	Summer	Winter				
18			SM T/M	+F27/FD1H	+G27/FD1S	+H27/FD1W			SM T/M	100
19			MED MRD	+F28/FD2H	+G28/FD2S	+H28/FD2W			MED MRD	160
20			MED MULT	+F29/FD3H	+G29/FD3S	+H29/FD3W			MED MULT	840
21			LGE MULT	+F30/FD4H	+G30/FD4S	+H30/FD4W			LGE MULT	720
22			CAT/PRO	+F31/FD5H	+G31/FD5S	+H31/FD5W			CAT/PRO	1212
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										

	E2323	E2411	E2412	E2413	E2421	E2422	E2423	E2511	E2512
38									
39									
40									
41	+$QF2W*$QF2	+$QF2H*$QF2	+$QF2S*$QF2	+$QF2W*$QF2	+$QF2H*$QF2	+$QF2S*$QF2	+$QF2W*$QF2	+$QF2H*$QF2	+$QF2S*$QF2
42	+$PP23*$APS	+$PP24*$APS	+$PP24*$APS	+$PP24*$APS	+$PP24*$APS	+$PP24*$APS	+$PP24*$APS	+$PP25*$APS	+$PP25*$APS
43	+AK41*AK42	+AL41*AL42	+AM41*AM42	+AN41*AN42	+AO41*AO42	+AP41*AP42	+AQ41*AQ42	+AR41*AR42	+AS41*AS42
44	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA
45	(AK41*AK42)	(AL41*AL42)	(AM41*AM42)	(AN41*AN42)	(AO41*AO42)	(AP41*AP42)	(AQ41*AQ42)	(AR41*AR42)	(AS41*AS42)
46	((AK41*AK42	((AL41*AL42	((AM41*AM42	((AN41*AN42	((AO41*AO42	((AP41*AP42	((AQ41*AQ42	((AR41*AR42	((AS41*AS42
47									
48	+AK40*AK41	+AL40*AL41	+AM40*AM41	+AN40*AN41	+AO40*AO41	+AP40*AP41	+AQ40*AQ41	+AR40*AR41	+AS40*AS41
49									
50	(AK41*AK42)	(AL41*AL42)	(AM41*AM42)	(AN41*AN42)	(AO41*AO42)	(AP41*AP42)	(AQ41*AQ42)	(AR41*AR42)	(AS41*AS42)
51	+AK40*AK50	+AL40*AL50	+AM40*AM50	+AN40*AN50	+AO40*AO50	+AP40*AP50	+AQ40*AQ50	+AR40*AR50	+AS40*AS50

	A	AT	AU	AV	AW	AX	AY	AZ	BA
HCMULT1.WKS									
@NOW									
4									
5					PREMIUM PRICE RATIO BY FLEET/SPECIES [PPii]				
6					Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7				SM T/M-Flt 1	1.25	1.25	1	1.1	0.75
8				MED MR-Flt 2	1.25	1.5	1	1	0.75
9				M.MULT-Flt 3	1	1	1	1	1.25
10				L.MULT-Flt 4	0.75	0.75	1	0.7	1
11				CAT/PR-Flt 5	0.5	0.5	1	0.5	0.5
12				Average Price [APSi]	$2.65	$1.50	$4.02	$1.10	$2.35
13									
14									
15									
16					AREA COST			SEASON PRICE	
17					RATIO [CRAi]			RATIO [PRSi]	
18				Ar 1- MHI	+S23/(S23-ARDA1)			SEAH =	1.5
19				Ar 2-Lw NWHI	+S23/(S23-ARDA2)			SEAS =	0.75
20				Ar 3-Up NWHI	+S23/(S23-ARDA3)			SEAW =	1
21				Ar 4-OffShor	+S23/(S23-ARDA4)				
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38		E2513	E2521	E2522	E2523	E3111	E3112	E3113	E3121
39		---	---	---	---	---	---	---	---
40			1373						116
41		+$QF2W*$QF2	+$QF2H*$QF2	+$QF2S*$QF2	+$QF2W*$QF2	+$QF3H*$QF3S1*$Q	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3
42		+$PP25*$APS	+$PP25*$APS	+$PP25*$APS	+$PP25*$APS	+$PP31*$APS1*$PR	+$PP31*$APS	+$PP31*$APS	+$PP31*$APS
43		+AT41*AT42	+AU41*AU42	+AV41*AV42	+AW41*AW42	+AX41*AX42	+AY41*AY42	+AZ41*AZ42	+BA41*BA42
44		+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV2*$CRA	+$OCV3*$CRA1	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA
45		(AT41*AT42)	(AU41*AU42)	(AV41*AV42)	(AW41*AW42)	(AX41*AX42)*0.1	(AY41*AY42)	(AZ41*AZ42)	(BA41*BA42)
46		((AT41*AT42	((AU41*AU42	((AV41*AV42	((AW41*AW42	((AX41*AX42)-(AX	((AY41*AY42	((AZ41*AZ42	((BA41*BA42
47									
48		+AT40*AT41	+AU40*AU41	+AV40*AV41	+AW40*AW41	+AX40*AX41	+AY40*AY41	+AZ40*AZ41	+BA40*BA41
49									
50		(AT41*AT42)	(AU41*AU42)	(AV41*AV42)	(AW41*AW42)	(AX41*AX42)-(AX4	(AY41*AY42)	(AZ41*AZ42)	(BA41*BA42)
51		+AT40*AT50	+AU40*AU50	+AV40*AV50	+AW40*AW50	+AX40*AX50	+AY40*AY50	+AZ40*AZ50	+BA40*BA50

	A	BB	BC	BD	BE	BF	BG
	HCMULT1.WKS						
	@NOW						
4							
5				CATCH RATIO FLEET/SEASON [qFil]			
6				Holiday	Summer	Winter	
7			SM T/M	0.8	1.25	0.75	
8			MED MRD	1	1.5	0.75	
9			MED MULT	1	1.25	0.85	
10			LGE MULT	1	1.25	0.85	
11			CAT/PRO	1	1.1	0.9	
12							
13							
14							
15							
16				CREW SHARES [CSHi]			
17				(% of boat revenue)			
18				SM T/M	0.3		
19				MED MRD	0.4		
20				MED MULT	0.47		
21				LGE MULT	0.36		
22				CAT/PRO	0.4		
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							

	E3122	E3123	E3131	E3132	E3133	E3211
38						
39						
40				417		
41	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3
42	+$PP31*$APS	+$PP31*$APS	+$PP31*$APS	+$PP31*$APS	+$PP31*$APS	+$PP32*$APS
43	+BB41*BB42	+BC41*BC42	+BD41*BD42	+BE41*BE42	+BF41*BF42	+BG41*BG42
44	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA
45	(BB41*BB42)	(BC41*BC42)	(BD41*BD42)	(BE41*BE42)	(BF41*BF42)	(BG41*BG42)
46	((BB41*BB42	((BC41*BC42	((BD41*BD42	((BE41*BE42	((BF41*BF42	((BG41*BG42
47						
48	+BB40*BB41	+BC40*BC41	+BD40*BD41	+BE40*BE41	+BF40*BF41	+BG40*BG41
49						
50	(BB41*BB42)	(BC41*BC42)	(BD41*BD42)	(BE41*BE42)	(BF41*BF42)	(BG41*BG42)
51	+BB40*BB50	+BC40*BC50	+BD40*BD50	+BE40*BE50	+BF40*BF50	+BG40*BG50

A	BG	BH	BI	BJ	BK	BL	BM	BN
HCMULT1.WKS								
@NOW								
4								
5				AVERAGE CATCH RATE (q) FLEET/SPECIES [qFiSi]				
6				Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
7			SM T/M	75	63	42	50	225
8			MED MRD	88	81	56	100	340
9			MED MULT	909	682	385	500	682
10			LGE MULT	709	682	708	1500	1364
11			CAT/PRO	682	682	1185	750	1364
12								
13								
14								
15								
16					SPECIES POUNDAGE LIMITS (Q) BY AREA			
17				Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI
18			Ar 1- MHI	+HQ60	+HQ64	+HQ69	+HQ73	+HQ78
19			Ar 2-Lw NWHI	+HQ61	+HQ65	+HQ70	+HQ74	+HQ79
20			Ar 3-Up NWHI	+HQ62	+HQ66	+HQ71	+HQ75	+HQ80
21			Ar 4-OffShor	0	+HQ67	0	+HQ76	+HQ81
22			TOTAL LBS	+HQ63	+HQ68	+HQ72	+HQ77	+HQ82
23								
24								
25								
26								
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31								
32								
33								
34								
35								
36								
37								

	E3211	E3212	E3213	E3221	E3222	E3223	E3231	E3232
					1787			
41	+$QF3H*$QF3	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3	+$QF3S*$QF3
42	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS
43	+BG41*BG42	+BH41*BH42	+BI41*BI42	+BJ41*BJ42	+BK41*BK42	+BL41*BL42	+BM41*BM42	+BN41*BN42
44	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA
45	(BG41*BG42)	(BH41*BH42)	(BI41*BI42)	(BJ41*BJ42)	(BK41*BK42)	(BL41*BL42)	(BM41*BM42)	(BN41*BN42)
46	((BG41*BG42	((BH41*BH42	((BI41*BI42	((BJ41*BJ42	((BK41*BK42	((BL41*BL42	((BM41*BM42	((BN41*BN42
47								
48	+BG40*BG41	+BH40*BH41	+BI40*BI41	+BJ40*BJ41	+BK40*BK41	+BL40*BL41	+BM40*BM41	+BN40*BN41
49								
50	(BG41*BG42)	(BH41*BH42)	(BI41*BI42)	(BJ41*BJ42)	(BK41*BK42)	(BL41*BL42)	(BM41*BM42)	(BN41*BN42)
51	+BG40*BG50	+BH40*BH50	+BI40*BI50	+BJ40*BJ50	+BK40*BK50	+BL40*BL50	+BM40*BM50	+BN40*BN50

A	BN	BO	BP	BQ	BR	BS	BT	BU
HCMULT1.WKS								
@NOW								
4								
5				CATCH (q) RATIO AREA/SPECIES [qAiSi]				
6			Sp 1-BTTM	Sp 2-PMUS	Sp 3-LOBS	Sp 4-AKU	Sp 5-AHI	
7		Ar 1- MHI	0.8	0.8	0.6	1	0.8	
8		Ar 2-Lw NWHI	1.2	1.2	1.2	1	1	
9		Ar 3-Up NWHI	1	1.2	1.4	1	1	
10		Ar 4-OffShor	0	1	0	1	1.2	
11								
12								
13								
14								
15								
16								
17								
18								
19								
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21								
22								
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25								
26								
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33								
34								
35								
36								
37								

	E3232	E3233	E3241	E3242	E3243	E3311	E3313	E3321
38								
39								
40								
41	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3	+$QF3S*$QF3	+$QF3W*$QF3	+$QF3H*$QF3	+$QF3W*$QF3	+$QF3H*$QF3
42	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP32*$APS	+$PP33*$APS	+$PP33*$APS	+$PP33*$APS
43	+BN41*BN42	+BO41*BO42	+BP41*BP42	+BQ41*BQ42	+BR41*BR42	+BS41*BS42	+BT41*BT42	+BU41*BU42
44	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA	+$OCV3*$CRA
45	(BN41*BN42)	(BO41*BO42)	(BP41*BP42)	(BQ41*BQ42)	(BR41*BR42)	(BS41*BS42)	(BT41*BT42)	(BU41*BU42)
46	((BN41*BN42	((BO41*BO42	((BP41*BP42	((BQ41*BQ42	((BR41*BR42	((BS41*BS42	((BT41*BT42	((BU41*BU42
47								
48	+BN40*BN41	+BO40*BO41	+BP40*BP41	+BQ40*BQ41	+BR40*BR41	+BS40*BS41	+BT40*BT41	+BU40*BU41
49								
50	(BN41*BN42)	(BO41*BO42)	(BP41*BP42)	(BQ41*BQ42)	(BR41*BR42)	(BS41*BS42)	(BT41*BT42)	(BU41*BU42)
51	+BN40*BN50	+BO40*BO50	+BP40*BP50	+BQ40*BQ50	+BR40*BR50	+BS40*BS50	+BT40*BT50	+BU40*BU50

A		HN	HO	HP		HQ
	37					
	38	K5--2	K5--3	NET PROFIT		LIMITS AVAIL
	39	---	---	---	---	---
	40	2.5	2.5	10841266		
	41					
	42					
	43					
	44					
	45					
	46					
	47	+$FCV5*(F5S	+$FCV5*(F5S3/$TFD5)			
	48					
	49					
	50	(HN41*HN42)	(HO41*HO42)-(HO44+HO45+(@IF(HO46>=0,HO46,0))+HO47)			
	51	+HN40*HN50	+HO40*HO50			
	52					
	53					
	54	+$FLT05	+$FLT05			
	55					
	56	+$FLT5	+$FLT5			
	57					
	58					
	59					
	60				<=	627000
	61				<=	126000
	62				<=	474000
	63				<=	1227000
	64				<=	4687500
	65				<=	4687500
	66				<=	4687500
	67				<=	7500000
	68				<=	7500000
	69				<=	12500
	70				<=	656250
	71				<=	1218750
	72				<=	1500000
	73				<=	15000000
	74				<=	15000000
	75				<=	15000000
	76				<=	15000000
	77				<=	15000000
	78				<=	15000000
	79				<=	15000000
	80				<=	15000000
	81				<=	15000000
	82				<=	15000000
	83				<=	0
	84				<=	0
	85				<=	0

APPENDIX - ITEM A3: RANGE NAME LISTING

NAME	LOCATION	
83CA	HT60..HT97	} constraint's solution activity
83CONSTRAINTS	F60..HQ97	} constraint region
83COST	G50..HO50	} variable's marginal net revenue
83CR	HU60..HU97	} constraint's reduced cost
83LOWER	G54..HO54	} solution's lower limits
83TITLE	F2	
83UPPER	G56..HO56	} solution's upper limits
83VA	G40..HP40	} variable's solution activity
83VARIABLE	G38..HO38	} problem's variables
AFDF1	AB7	
AFDF2	AB8	
AFDF3	AB9	} Ave. Fishing Days per trip for Fleet #
AFDF4	AB10	
AFDF5	AB11	
APS1	AW12	
APS2	AX12	
APS3	AY12	} Ave. Price for Species #
APS4	AZ12	
APS5	BA12	
ARDA1	AF7	
ARDA2	AF8	} Ave. Running Days per trip in Area #
ARDA3	AF9	
ARDA4	AF10	
ARDF1	AI7	
ARDF2	AI8	
ARDF3	AI9	} Ave. Running Days per trip for Fleet #
ARDF4	AI10	
ARDF5	AI11	
CRA1	AX18	
CRA2	AX19	} Cost Ratio for Area #
CRA3	AX20	
CRA4	AX21	
CSH1	BE18	
CSH2	BE19	
CSH3	BE20	} Crew Share (percent) for fleet #
CSH4	BE21	
CSH5	BE22	

F1S1	F18	
F1S2	G18	
F1S3	H18	
F2S1	F19	
F2S2	G19	
F2S3	H19	
F3S1	F20	} expected total potential fishing days
F3S2	G20	} for Fleet # in Season #
F3S3	H20	
F4S1	F21	
F4S2	G21	
F4S3	H21	
F5S1	F22	
F5S2	G22	
F5S3	H22	
FCV1	AS7	
FCV2	AS8	
FCV3	AS9	} annual Fixed Costs per Vessel in fleet #
FCV4	AS10	
FCV5	AS11	
FD1H	AA18	
FD1S	AB18	
FD1W	AC18	
FD2H	AA19	
FD2S	AB19	
FD2W	AC19	
FD3H	AA20	} average Fishing Days for fleet #
FD3S	AB20	} in season "L"
FD3W	AC20	
FD4H	AA21	
FD4S	AB21	
FD4W	AC21	
FD5H	AA22	
FD5S	AB22	
FD5W	AC22	
FLT01	F7	
FLT02	F8	
FLT03	F9	} minimum number of vessels in FLeeT #
FLT04	F10	
FLT05	F11	
FLT1	G7	
FLT2	G8	
FLT3	G9	} maximum number of vessels in FLeeT #
FLT4	G10	
FLT5	G11	

OCV1	AS18	
OCV2	AS19	
OCV3	AS20	} average daily Operating Costs for
OCV4	AS21	} Vessels in fleet #
OCV5	AS22	
OD1H	Q18	
OD1S	R18	
OD1W	S18	
OD2H	Q19	
OD2S	R19	
OD2W	S19	
OD3H	Q20	} average Operating Days for
OD3S	R20	} fleet # in season "L"
OD3W	S20	
OD4H	Q21	
OD4S	R21	
OD4W	S21	
OD5H	Q22	
OD5S	R22	
OD5W	S22	
PP11	AW7	
PP12	AX7	
PP13	AY7	
PP14	AZ7	
PP15	BA7	
PP21	AW8	
PP22	AX8	
PP23	AY8	
PP24	AZ8	} Premium Price ratio for fleet #
PP25	BA8	} harvesting species #
PP31	AW9	
PP32	AX9	
PP33	AY9	
PP34	AZ9	
PP35	BA9	
PP41	AW10	
PP42	AX10	
PP43	AY10	
PP44	AZ10	
PP45	BA10	
PP51	AW11	
PP52	AX11	
PP53	AY11	
PP54	AZ11	
PP55	BA11	
PRS1	BA18	
PRS2	BA19	} Price Ratio for Season #
PRS3	BA20	

PT1H	AM7	
PT1S	AN7	
PT1W	AO7	
PT2H	AM8	
PT2S	AN8	
PT2W	AO8	
PT3H	AM9	} Potential Trips for fleet #
PT3S	AN9	} in season "L"
PT3W	AO9	
PT4H	AM10	
PT4S	AN10	
PT4W	AO10	
PT5H	AM11	
PT5S	AN11	
PT5W	AO11	
QA1S1	BP7	
QA1S2	BQ7	
QA1S3	BR7	
QA1S4	BS7	
QA1S5	BT7	
QA2S1	BP8	
QA2S2	BQ8	
QA2S3	BR8	} catch rate (q) ratio in Area #
QA2S4	BS8	} of Species #
QA2S5	BT8	
QA3S1	BP9	
QA3S2	BQ9	
QA3S3	BR9	
QA3S4	BS9	
QA3S5	BT9	
QA4S1	BP10	
QA4S2	BQ10	
QA4S3	BR10	
QA4S4	BS10	
QA4S5	BT10	
QF1H	BD7	
QF1S	BE7	
QF1W	BF7	
QF2H	BD8	
QF2S	BE8	
QF2W	BF8	} catch rate (q) ratio for
QF3H	BD9	} Fleet # in season "L"
QF3S	BE9	
QF3W	BF9	
QF4H	BD10	
QF4S	BE10	
QF4W	BF10	
QF5H	BD11	
QF5S	BE11	
QF5W	BF11	

QF1S1	BI7	
QF1S2	BJ7	
QF1S3	BK7	
QF1S4	BL7	
QF1S5	BM7	
QF2S1	BI8	
QF2S2	BJ8	
QF2S3	BK8	
QF2S4	BL8	
QF2S5	BM8	
QF3S1	BI9	
QF3S2	BJ9	} average catch rate (q) of Fleet #
QF3S3	BK9	} harvesting Species #
QF3S4	BL9	
QF3S5	BM9	
QF4S1	BI10	
QF4S2	BJ10	
QF4S3	BK10	
QF4S4	BL10	
QF4S5	BM10	
QF5S1	BI11	
QF5S2	BJ11	
QF5S3	BK11	
QF5S4	BL11	
QF5S5	BM11	
RD1H	AF18	
RD1S	AG18	
RD1W	AH18	
RD2H	AF19	
RD2S	AG19	
RD2W	AH19	
RD3H	AF20	} average Running Days per trip
RD3S	AG20	} for fleet # in season "L"
RD3W	AH20	
RD4H	AF21	
RD4S	AG21	
RD4W	AH21	
RD5H	AF22	
RD5S	AG22	
RD5W	AH22	
SEAH	W7	
SEAS	W8	} calendar days in SEAson "L"
SEAW	W9	

TD1H	V18		
TD1S	W18		
TD1W	X18		
TD2H	V19		
TD2S	W19		
TD2W	X19		
TD3H	V20		
TD3S	W20	}	Turn-around Days for fleet #
TD3W	X20	}	in season "L"
TD4H	V21		
TD4S	W21		
TD4W	X21		
TD5H	V22		
TD5S	W22		
TD5W	X22		
TFD1	I18		
TFD2	I19		
TFD3	I20		
TFD4	I21		
TFD5	I22		

APPENDIX - ITEM A4: MULTIFISHERY PARAMETER LISTING

PARMULT VARIABLE	SOLUTION FISH DAYS	CATCH RT (q)	PRICE (p)	REVENUE (R)	OP. COST (c)	HD. COST (hc)	CW SHARE (cs)	ANN. FIX COST/BOAT	CATCH PER Eijkm	MG. REV.	NET REV. BEFOR FC
E1111		48	$4.97	$238.50	$101.13	$23.85	$34.06		0	$79.46	$0
E1112	8,360	75	$2.48	$186.33	$101.13	$18.63	$19.97		627,000	$46.59	$389,530
E1113		45	$3.31	$149.06	$101.13	$14.91	$9.91		0	$23.12	$0
E1211		40	$2.81	$113.40	$101.13	$11.34	$0.28		0	$0.65	$0
E1212		63	$1.41	$88.59	$101.13	$8.86	($6.42)		0	($21.40)	$0
E1213		38	$1.88	$70.88	$101.13	$7.09	($11.20)		0	($37.34)	$0
E1311		20	$6.03	$121.56	$101.13	$12.16	$2.48		0	$5.79	$0
E1313		19	$4.02	$75.98	$101.13	$7.60	($9.83)		0	($32.75)	$0
E1411		40	$1.82	$72.60	$101.13	$7.26	($10.74)		0	($35.79)	$0
E1412		63	$0.91	$56.72	$101.13	$5.67	($15.03)		0	($50.08)	$0
E1413		38	$1.21	$45.38	$101.13	$4.54	($18.09)		0	($60.29)	$0
E1511	7,200	144	$2.64	$380.70	$101.13	$38.07	$72.45		1,036,800	$169.05	$1,217,151
E1512		225	$1.32	$297.42	$101.13	$29.74	$49.96		0	$116.58	$0
E1513	7,579	135	$1.76	$237.94	$101.13	$23.79	$33.90		1,023,158	$79.11	$599,559
E2111		70	$4.97	$349.80	$161.81	$34.98	$61.20		0	$91.81	$0
E2112		106	$2.48	$262.35	$161.81	$26.24	$29.72		0	$44.58	$0
E2113		53	$3.31	$174.90	$161.81	$17.49	($1.76)		0	($4.40)	$0
E2121		106	$4.97	$524.70	$188.06	$52.47	$113.67		0	$170.50	$0
E2122		158	$2.48	$393.53	$188.06	$39.35	$66.45		0	$99.67	$0
E2123		79	$3.31	$262.35	$188.06	$26.24	$19.22		0	$28.83	$0
E2211		65	$3.38	$218.70	$161.81	$21.87	$14.01		0	$21.01	$0
E2212		97	$1.69	$164.03	$161.81	$16.40	($5.68)		0	($14.19)	$0
E2213		49	$2.25	$109.35	$161.81	$10.94	($25.36)		0	($63.40)	$0
E2221		97	$3.38	$328.05	$188.06	$32.81	$42.87		0	$64.31	$0
E2222	1,398	146	$1.69	$246.04	$188.06	$24.60	$13.35		203,837	$20.02	$27,996
E2223		73	$2.25	$164.02	$188.06	$16.40	($16.17)		0	($40.44)	$0
E2311		34	$6.03	$202.61	$161.81	$20.26	$8.21		0	$12.32	$0
E2313		25	$4.02	$101.30	$161.81	$10.13	($28.25)		0	($70.64)	$0
E2321		67	$6.03	$405.22	$188.06	$40.52	$70.65		0	$105.98	$0
E2322		101	$3.01	$303.91	$188.06	$30.39	$34.18		0	$51.28	$0
E2323		50	$4.02	$202.61	$188.06	$20.26	($2.28)		0	($5.71)	$0
E2411		100	$1.65	$165.00	$161.81	$16.50	($5.32)		0	($13.31)	$0
E2412		150	$0.83	$123.75	$161.81	$12.38	($20.17)		0	($50.44)	$0
E2413		75	$1.10	$82.50	$161.81	$8.25	($35.02)		0	($87.56)	$0
E2421		100	$1.65	$165.00	$188.06	$16.50	($15.82)		0	($39.56)	$0
E2422		150	$0.83	$123.75	$188.06	$12.38	($30.67)		0	($76.68)	$0
E2423		75	$1.10	$82.50	$188.06	$8.25	($45.52)		0	($113.81)	$0
E2511		272	$2.64	$719.10	$161.81	$71.91	$194.15		0	$291.23	$0
E2512		408	$1.32	$539.33	$161.81	$53.93	$129.43		0	$194.15	$0
E2513		204	$1.76	$359.55	$161.81	$35.96	$64.71		0	$97.07	$0
E2521	1,373	340	$2.64	$898.88	$188.06	$89.89	$248.37		466,667	$372.56	$511,353
E2522		510	$1.32	$674.16	$188.06	$67.42	$167.47		0	$251.21	$0
E2523		255	$1.76	$449.44	$188.06	$44.94	$86.57		0	$129.86	$0
E3111		727	$3.98	$2,890.62	$849.51	$289.06	$823.46		0	$928.59	$0
E3112		909	$1.99	$1,806.64	$849.51	$180.66	$364.94		0	$411.53	$0
E3113		618	$2.65	$1,638.02	$849.51	$163.80	$293.61		0	$331.10	$0
E3121	116	1091	$3.98	$4,335.93	$987.31	$433.59	$1,370.06		126,000	$1,544.96	$178,461
E3122		1364	$1.99	$2,709.96	$987.31	$271.00	$682.28		0	$769.37	$0
E3123		927	$2.65	$2,457.03	$987.31	$245.70	$575.29		0	$648.73	$0
E3131		909	$3.98	$3,613.28	$1,197.28	$361.33	$965.70		0	$1,088.98	$0

PARMULT VARIABLE	SOLUTION FISH DAYS	CATCH RT (q)	PRICE (p)	REVENUE (R)	OP. COST (c)	HD. COST (hc)	CW SHARE (cs)	ANN. FIX COST/BOAT	CATCH PER Eijkm	MG. REV.	NET REV. BEFOR FC
E3132	417	1136	$1.99	$2,258.30	$1,197.28	$225.83	$392.54		474,000	$442.65	$184,657
E3133		773	$2.65	$2,047.52	$1,197.28	$204.75	$303.38		0	$342.11	$0
E3211		546	$2.25	$1,227.60	$849.51	$122.76	$120.01		0	$135.33	$0
E3212		682	$1.13	$767.25	$849.51	$76.73	($74.72)		0	($158.98)	$0
E3213		464	$1.50	$695.64	$849.51	$69.56	($105.01)		0	($223.43)	$0
E3221		818	$2.25	$1,841.40	$987.31	$184.14	$314.88		0	$355.07	$0
E3222	1,787	1023	$1.13	$1,150.88	$987.31	$115.09	$22.78		1,828,019	$25.69	$45,911
E3223		696	$1.50	$1,043.46	$987.31	$104.35	($22.65)		0	($48.20)	$0
E3231		818	$2.25	$1,841.40	$1,197.28	$184.14	$216.19		0	$243.79	$0
E3232		1023	$1.13	$1,150.88	$1,197.28	$115.09	($75.90)		0	($161.49)	$0
E3233		696	$1.50	$1,043.46	$1,197.28	$104.35	($121.34)		0	($258.16)	$0
E3241		682	$2.25	$1,534.50	$945.84	$153.45	$204.55		0	$230.66	$0
E3242		853	$1.13	$959.06	$945.84	$95.91	($38.86)		0	($82.69)	$0
E3243		580	$1.50	$869.55	$945.84	$86.96	($76.73)		0	($163.25)	$0
E3311		231	$6.03	$1,392.93	$849.51	$139.29	$189.94		0	$214.19	$0
E3313		196	$4.02	$789.33	$849.51	$78.93	($65.38)		0	($139.11)	$0
E3321		462	$6.03	$2,785.86	$987.31	$278.59	$714.38		0	$805.58	$0
E3322		578	$3.01	$1,741.16	$987.31	$174.12	$272.48		0	$307.26	$0
E3323		393	$4.02	$1,578.65	$987.31	$157.87	$203.73		0	$229.74	$0
E3331		539	$6.03	$3,250.17	$1,197.28	$325.02	$812.10		0	$915.77	$0
E3332		674	$3.01	$2,031.36	$1,197.28	$203.14	$296.54		0	$334.40	$0
E3333		458	$4.02	$1,841.76	$1,197.28	$184.18	$216.35		0	$243.96	$0
E3411		500	$1.65	$825.00	$849.51	$82.50	($50.29)		0	($107.01)	$0
E3412		625	$0.83	$515.63	$849.51	$51.56	($181.16)		0	($385.44)	$0
E3413		425	$1.10	$467.50	$849.51	$46.75	($201.52)		0	($428.76)	$0
E3421		500	$1.65	$825.00	$987.31	$82.50	($115.06)		0	($244.81)	$0
E3422		625	$0.83	$515.63	$987.31	$51.56	($245.93)		0	($523.25)	$0
E3423		425	$1.10	$467.50	$987.31	$46.75	($266.28)		0	($566.56)	$0
E3431		500	$1.65	$825.00	$1,197.28	$82.50	($213.74)		0	($454.78)	$0
E3432		625	$0.83	$515.63	$1,197.28	$51.56	($344.61)		0	($733.21)	$0
E3433		425	$1.10	$467.50	$1,197.28	$46.75	($364.97)		0	($776.53)	$0
E3441		500	$1.65	$825.00	$945.84	$82.50	($95.57)		0	($203.34)	$0
E3442		625	$0.83	$515.63	$945.84	$51.56	($226.44)		0	($481.78)	$0
E3443		425	$1.10	$467.50	$945.84	$46.75	($246.79)		0	($525.09)	$0
E3511		546	$4.41	$2,404.05	$849.51	$240.41	$617.65		0	$696.49	$0
E3512		682	$2.20	$1,502.53	$849.51	$150.25	$236.30		0	$266.47	$0
E3513		464	$2.94	$1,362.30	$849.51	$136.23	$176.98		0	$199.58	$0
E3521		682	$4.41	$3,005.06	$987.31	$300.51	$807.11		0	$910.14	$0
E3522		853	$2.20	$1,878.16	$987.31	$187.82	$330.43		0	$372.61	$0
E3523		580	$2.94	$1,702.87	$987.31	$170.29	$256.28		0	$288.99	$0
E3531		682	$4.41	$3,005.06	$1,197.28	$300.51	$708.42		0	$798.86	$0
E3532		853	$2.20	$1,878.16	$1,197.28	$187.82	$231.74		0	$261.33	$0
E3533		580	$2.94	$1,702.87	$1,197.28	$170.29	$157.59		0	$177.71	$0
E3541	1,984	818	$4.41	$3,606.08	$945.84	$360.61	$1,080.82		1,624,105	$1,218.80	$2,418,697
E3542		1023	$2.20	$2,253.80	$945.84	$225.38	$508.81		0	$573.76	$0
E3543	2,494	696	$2.94	$2,043.44	$945.84	$204.34	$419.83		1,735,020	$473.43	$1,180,787
E4111		567	$2.98	$1,690.97	$728.15	$169.10	$285.74		0	$507.98	$0
E4112		709	$1.49	$1,056.85	$728.15	$105.69	$80.29		0	$142.73	$0
E4113		482	$1.99	$958.21	$728.15	$95.82	$48.33		0	$85.92	$0
E4121		851	$2.98	$2,536.45	$846.27	$253.64	$517.15		0	$919.38	$0
E4122		1064	$1.49	$1,585.28	$846.27	$158.53	$208.97		0	$371.51	$0
E4123		723	$1.99	$1,437.32	$846.27	$143.73	$161.04		0	$286.29	$0

PARMULT VARIABLE	SOLUTION FISH DAYS	CATCH RT (q)	PRICE (p)	REVENUE (R)	OP. COST (c)	HD. COST (hc)	CW SHARE (cs)	ANN. FIX COST/BOAT	CATCH PER Eijkm	MG. REV.	NET REV. BEFOR FC
E4131		709	$2.98	$2,113.71	$1,026.24	$211.37	$315.40		0	$560.70	$0
E4132		886	$1.49	$1,321.07	$1,026.24	$132.11	$58.58		0	$104.14	$0
E4133		603	$1.99	$1,197.77	$1,026.24	$119.78	$18.63		0	$33.12	$0
E4211		546	$1.69	$920.70	$728.15	$92.07	$36.17		0	$64.31	$0
E4212		682	$0.84	$575.44	$728.15	$57.54	($75.69)		0	($210.25)	$0
E4213		464	$1.13	$521.73	$728.15	$52.17	($93.09)		0	($258.59)	$0
E4221		818	$1.69	$1,381.05	$846.27	$138.11	$142.80		0	$253.87	$0
E4222		1023	$0.84	$863.16	$846.27	$86.32	($24.99)		0	($69.43)	$0
E4223		696	$1.13	$782.60	$846.27	$78.26	($51.09)		0	($141.93)	$0
E4231		818	$1.69	$1,381.05	$1,026.24	$138.11	$78.02		0	$138.69	$0
E4232		1023	$0.84	$863.16	$1,026.24	$86.32	($89.78)		0	($249.40)	$0
E4233		696	$1.13	$782.60	$1,026.24	$78.26	($115.88)		0	($321.90)	$0
E4241		682	$1.69	$1,150.88	$810.72	$115.09	$81.02		0	$144.04	$0
E4242		853	$0.84	$719.30	$810.72	$71.93	($58.81)		0	($163.35)	$0
E4243		580	$1.13	$652.16	$810.72	$65.22	($80.56)		0	($223.78)	$0
E4311		425	$6.03	$2,561.54	$728.15	$256.15	$567.81		0	$1,009.43	$0
E4313		361	$4.02	$1,451.54	$728.15	$145.15	$208.17		0	$370.07	$0
E4321		850	$6.03	$5,123.09	$846.27	$512.31	$1,355.22		0	$2,409.29	$0
E4322		1062	$3.01	$3,201.93	$846.27	$320.19	$732.77		0	$1,302.70	$0
E4323		722	$4.02	$2,903.08	$846.27	$290.31	$635.94		0	$1,130.57	$0
E4331	228	991	$6.03	$5,976.94	$1,026.24	$597.69	$1,567.08		226,280	$2,785.92	$635,995
E4332		1239	$3.01	$3,735.58	$1,026.24	$373.56	$840.88		0	$1,494.91	$0
E4333		843	$4.02	$3,386.93	$1,026.24	$338.69	$727.92		0	$1,294.08	$0
E4411		1500	$1.16	$1,732.50	$728.15	$173.25	$299.20		0	$531.91	$0
E4412		1875	$0.58	$1,082.81	$728.15	$108.28	$88.70		0	$157.69	$0
E4413		1275	$0.77	$981.75	$728.15	$98.18	$55.95		0	$99.47	$0
E4421		1500	$1.16	$1,732.50	$846.27	$173.25	$256.67		0	$456.31	$0
E4422		1875	$0.58	$1,082.81	$846.27	$108.28	$46.18		0	$82.09	$0
E4423		1275	$0.77	$981.75	$846.27	$98.18	$13.43		0	$23.88	$0
E4431		1500	$1.16	$1,732.50	$1,026.24	$173.25	$191.88		0	$341.13	$0
E4432		1875	$0.58	$1,082.81	$1,026.24	$108.28	($18.61)		0	($51.71)	$0
E4433		1275	$0.77	$981.75	$1,026.24	$98.18	($51.36)		0	($142.66)	$0
E4441		1500	$1.16	$1,732.50	$810.72	$173.25	$269.47		0	$479.06	$0
E4442		1875	$0.58	$1,082.81	$810.72	$108.28	$58.97		0	$104.84	$0
E4443		1275	$0.77	$981.75	$810.72	$98.18	$26.23		0	$46.63	$0
E4511		1091	$3.53	$3,846.48	$728.15	$384.65	$984.13		0	$1,749.56	$0
E4512		1364	$1.76	$2,404.05	$728.15	$240.41	$516.78		0	$918.72	$0
E4513		928	$2.35	$2,179.67	$728.15	$217.97	$444.08		0	$789.48	$0
E4521		1364	$3.53	$4,808.10	$846.27	$480.81	$1,253.17		0	$2,227.86	$0
E4522		1705	$1.76	$3,005.06	$846.27	$300.51	$668.98		0	$1,189.31	$0
E4523		1159	$2.35	$2,724.59	$846.27	$272.46	$578.11		0	$1,027.75	$0
E4531		1364	$3.53	$4,808.10	$1,026.24	$480.81	$1,188.38		0	$2,112.67	$0
E4532		1705	$1.76	$3,005.06	$1,026.24	$300.51	$604.20		0	$1,074.12	$0
E4533		1159	$2.35	$2,724.59	$1,026.24	$272.46	$513.32		0	$912.57	$0
E4541	763	1637	$3.53	$5,769.72	$810.72	$576.97	$1,577.53		1,248,904	$2,804.50	$2,139,874
E4542	1,982	2046	$1.76	$3,606.08	$810.72	$360.61	$876.51		4,054,570	$1,558.24	$3,087,968
E4543	2,739	1391	$2.35	$3,269.51	$810.72	$326.95	$767.46		3,810,776	$1,364.37	$3,737,081
E5111		546	$1.99	$1,084.38	$1,225.72	$108.44	($99.91)		0	($249.77)	$0
E5112		600	$0.99	$596.41	$1,225.72	$59.64	($275.58)		0	($688.95)	$0
E5113		491	$1.33	$650.63	$1,225.72	$65.06	($256.06)		0	($640.15)	$0
E5121		818	$1.99	$1,626.57	$1,424.55	$162.66	$15.75		0	$23.62	$0
E5122		900	$0.99	$894.61	$1,424.55	$89.46	($247.76)		0	($619.40)	$0

PARMULT VARIABLE	SOLUTION FISH DAYS	CATCH RT (q)	PRICE (p)	REVENUE (R)	OP. COST (c)	HD. COST (hc)	CW SHARE (cs)	ANN. FIX COST/BOAT	CATCH PER Eijkm	MG. REV.	NET REV. BEFOR FC
E5123		737	$1.33	$975.94	$1,424.55	$97.59	($218.48)		0	($546.20)	$0
E5131		682	$1.99	$1,355.48	$1,727.50	$135.55	($203.03)		0	($507.57)	$0
E5132		750	$0.99	$745.51	$1,727.50	$74.55	($422.62)		0	($1,056.54)	$0
E5133		614	$1.33	$813.29	$1,727.50	$81.33	($398.22)		0	($995.54)	$0
E5211		546	$1.13	$613.80	$1,225.72	$61.38	($269.32)		0	($673.30)	$0
E5212		600	$0.56	$337.59	$1,225.72	$33.76	($368.75)		0	($921.89)	$0
E5213		491	$0.75	$368.28	$1,225.72	$36.83	($357.71)		0	($894.26)	$0
E5221		818	$1.13	$920.70	$1,424.55	$92.07	($238.37)		0	($595.92)	$0
E5222		900	$0.56	$506.39	$1,424.55	$50.64	($387.52)		0	($968.80)	$0
E5223		737	$0.75	$552.42	$1,424.55	$55.24	($370.95)		0	($927.37)	$0
E5231		818	$1.13	$920.70	$1,727.50	$92.07	($359.55)		0	($898.87)	$0
E5232		900	$0.56	$506.39	$1,727.50	$50.64	($508.70)		0	($1,271.75)	$0
E5233		737	$0.75	$552.42	$1,727.50	$55.24	($492.13)		0	($1,230.32)	$0
E5241		682	$1.13	$767.25	$1,364.72	$76.73	($269.68)		0	($674.19)	$0
E5242		750	$0.56	$421.99	$1,364.72	$42.20	($393.97)		0	($984.93)	$0
E5243		614	$0.75	$460.35	$1,364.72	$46.04	($380.16)		0	($950.40)	$0
E5311		711	$6.03	$4,287.33	$1,225.72	$428.73	$1,053.15		0	$1,579.73	$0
E5313		640	$4.02	$2,572.40	$1,225.72	$257.24	$435.78		0	$653.67	$0
E5321		1422	$6.03	$8,574.66	$1,424.55	$857.47	$2,517.06		0	$3,775.59	$0
E5322	180	1564	$3.01	$4,716.06	$1,424.55	$471.61	$1,127.96		281,250	$1,691.95	$304,219
E5323		1280	$4.02	$5,144.80	$1,424.55	$514.48	$1,282.31		0	$1,923.46	$0
E5331	244	1659	$6.03	$10,003.77	$1,727.50	$1,000.38	$2,910.36		405,533	$4,365.54	$1,067,131
E5332	58	1825	$3.01	$5,502.07	$1,727.50	$550.21	$1,289.75		106,231	$1,934.62	$112,618
E5333	322	1493	$4.02	$6,002.26	$1,727.50	$600.23	$1,469.82		480,705	$2,204.72	$709,813
E5411		750	$0.83	$618.75	$1,225.72	$61.88	($267.54)		0	($668.84)	$0
E5412		825	$0.41	$340.31	$1,225.72	$34.03	($367.77)		0	($919.43)	$0
E5413		675	$0.55	$371.25	$1,225.72	$37.13	($356.64)		0	($891.59)	$0
E5421		750	$0.83	$618.75	$1,424.55	$61.88	($347.07)		0	($867.67)	$0
E5422		825	$0.41	$340.31	$1,424.55	$34.03	($447.31)		0	($1,118.27)	$0
E5423		675	$0.55	$371.25	$1,424.55	$37.13	($436.17)		0	($1,090.42)	$0
E5431		750	$0.83	$618.75	$1,727.50	$61.88	($468.25)		0	($1,170.62)	$0
E5432		825	$0.41	$340.31	$1,727.50	$34.03	($568.49)		0	($1,421.22)	$0
E5433		675	$0.55	$371.25	$1,727.50	$37.13	($557.35)		0	($1,393.37)	$0
E5441		750	$0.83	$618.75	$1,364.72	$61.88	($323.14)		0	($807.84)	$0
E5442		825	$0.41	$340.31	$1,364.72	$34.03	($423.37)		0	($1,058.43)	$0
E5443		675	$0.55	$371.25	$1,364.72	$37.13	($412.24)		0	($1,030.59)	$0
E5511		1091	$1.76	$1,923.24	$1,225.72	$192.32	$202.08		0	$303.12	$0
E5512		1200	$0.88	$1,057.78	$1,225.72	$105.78	($109.48)		0	($273.71)	$0
E5513		982	$1.18	$1,153.94	$1,225.72	$115.39	($74.87)		0	($187.17)	$0
E5521		1364	$1.76	$2,404.05	$1,424.55	$240.41	$295.64		0	$443.46	$0
E5522		1500	$0.88	$1,322.23	$1,424.55	$132.22	($93.82)		0	($234.54)	$0
E5523		1228	$1.18	$1,442.43	$1,424.55	$144.24	($50.54)		0	($126.36)	$0
E5531		1364	$1.76	$2,404.05	$1,727.50	$240.41	$174.46		0	$261.69	$0
E5532		1500	$0.88	$1,322.23	$1,727.50	$132.22	($215.00)		0	($537.49)	$0
E5533		1228	$1.18	$1,442.43	$1,727.50	$144.24	($171.72)		0	($429.31)	$0
E5541		1637	$1.76	$2,884.86	$1,364.72	$288.49	$492.66		0	$739.00	$0
E5542		1800	$0.88	$1,586.67	$1,364.72	$158.67	$25.32		0	$37.97	$0
E5543		1473	$1.18	$1,730.92	$1,364.72	$173.09	$77.24		0	$115.87	$0

PARMULT VARIABLE	SOLUTION FISH DAYS	CATCH RT (q)	PRICE (p)	REVENUE (R)	OP. COST (c)	HD. COST (hc)	CW SHARE (cs)	ANN. FIX COST/BOAT	CATCH PER Eijkm	MG. REV.	NET REV. BEFOR FC
K1--1	300							$1,142		($1,142)	($342,631)
K1--2	150							$3,253		($3,253)	($488,020)
K1--3	150							$2,404		($2,404)	($360,664)
K2--1	50							$3,719		($3,719)	($185,931)
K2--2	25							$7,575		($7,575)	($189,386)
K2--3	25							$8,706		($8,706)	($217,648)
K3--1	75							$9,133		($9,133)	($684,995)
K3--2	37.5							$19,172		($19,172)	($718,945)
K3--3	37.5							$21,695		($21,695)	($813,557)
K4--1	20							$22,436		($22,436)	($448,713)
K4--2	20							$45,573		($45,573)	($897,017)
K4--3	20							$61,991		($61,991)	($1,239,826)
K5--1	5							$68,081		($68,081)	($340,407)
K5--2	2.5							$132,582		($132,582)	($331,456)
K5--3	2.5							$179,336		($179,336)	($448,341)
PROFIT	$10,841,266										

		Pounds Avail	Pounds Used	Reduced Price
Q LIMITS	Q-11-	<= 627,000	627,000	$0.62
	Q-12-	<= 126,000	126,000	$0.70
	Q-13-	<= 474,000	474,000	$0.37
	Q-1--	<= 1,227,000	1,227,000	
	Q-21-	<= 4,687,500		
	Q-22-	<= 4,687,500	2,031,856	
	Q-23-	<= 4,687,500		
	Q-24-	<= 7,500,000		
	Q-2--	<= 7,500,000	2,031,856	
	Q-31-	<= 12,500		
	Q-32-	<= 656,250	281,250	
	Q-33-	<= 1,218,750	1,218,750	$0.01
	Q-3--	<= 1,500,000	1,500,000	$0.86
	Q-41-	<= 15,000,000		
	Q-42-	<= 15,000,000		
	Q-43-	<= 15,000,000		
	Q-44-	<= 15,000,000		
	Q-4--	<= 15,000,000		
	Q-51-	<= 15,000,000	2,059,958	
	Q-52-	<= 15,000,000	466,667	
	Q-53-	<= 15,000,000		
	Q-54-	<= 15,000,000	12,473,375	
	Q-5--	<= 15,000,000	15,000,000	$0.54

	Days Left When Used		Days NOT Used	Reduced Price
LIMITS E1--1	<=	0		$49.64
E1--2	<=	0	-1895	
E1--3	<=	0		$6.16
E2--1	<=	0		$188.83
E2--2	<=	0		$20.02
E2--3	<=	0	-1607	
E3--1	<=	0		$776.57
E3--2	<=	0		$25.69
E3--3	<=	0		$97.53
E4--1	<=	0		$1,920.03
E4--2	<=	0		$452.65
E4--3	<=	0		$612.57
E5--1	<=	0		$2,916.26
E5--2	<=	0		$340.42
E5--3	<=	0		$900.37

APPENDIX B

APPENDIX - B: LP83 REPORT FROM MULTIFISHERY MODEL

LP83 HCMULT1.WKS OUTPUT C:PMUL2 MAXIMIZE YES COSTANALYSIS YES MARGINANALYSIS YES

This is the DOS command to initiate an LP83 run.

..TITLE
(83TITLE)
Title: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

The following section lists all of the model's activity variables (both E and K) with their associated profit or loss potential (cost margin). A positive number to the left of an E variable means this fishing situation could earn that amount (in dollars) per fishing day allocated. A negative number indicates a potential LOSS (in dollars) per fishing. Costs associated with the K-variables are the seasonal proportion of annual fixed cost per boat of that fleet type.

..OBJECTIVE
(83VARIABLE)
(83COST)
Objective: MAXIMIZED Variables: 217

79	E1111	169	E1511
47	E1112	117	E1512
23	E1113	79	E1513
1	E1211	92	E2111
-21	E1212	45	E2112
-37	E1213	-4	E2113
6	E1311	171	E2121
-33	E1313	100	E2122
-36	E1411	29	E2123
-50	E1412	21	E2211
-60	E1413	-14	E2212
-63	E2213	-429	E3413

64	E2221
20	E2222
-40	E2223
12	E2311
-71	E2313
106	E2321
51	E2322
-6	E2323
-13	E2411
-50	E2412
-88	E2413
-40	E2421
-77	E2422
-114	E2423
291	E2511
194	E2512
97	E2513
373	E2521
251	E2522
130	E2523
929	E3111
412	E3112
331	E3113
1,545	E3121
769	E3122
649	E3123
1,089	E3131
443	E3132
342	E3133
135	E3211
-159	E3212
-223	E3213
355	E3221
26	E3222
-48	E3223
244	E3231
-161	E3232
-258	E3233
231	E3241
-83	E3242
-163	E3243
214	E3311
-139	E3313
806	E3321
307	E3322
230	E3323
916	E3331
334	E3332
244	E3333
-107	E3411
-385	E3412
-245	E3421
-523	E3422
-567	E3423
-455	E3431
-733	E3432
-777	E3433
-203	E3441
-482	E3442
-525	E3443
696	E3511
266	E3512
200	E3513
910	E3521
373	E3522
289	E3523
799	E3531
261	E3532
178	E3533
1,219	E3541
574	E3542
473	E3543
508	E4111
143	E4112
86	E4113
919	E4121
372	E4122
286	E4123
561	E4131
104	E4132
33	E4133
64	E4211
-210	E4212
-259	E4213
254	E4221
-69	E4222
-142	E4223
139	E4231
-249	E4232
-322	E4233
144	E4241
-163	E4242
-224	E4243
1,009	E4311
370	E4313
2,409	E4321
1,303	E4322
1,131	E4323
2,786	E4331
1,495	E4332
1,294	E4333
532	E4411

158	E4412
99	E4413
456	E4421
82	E4422
24	E4423
341	E4431
-52	E4432
-143	E4433
479	E4441
105	E4442
47	E4443
1,750	E4511
919	E4512
789	E4513
2,228	E4521
1,189	E4522
1,028	E4523
2,113	E4531
1,074	E4532
913	E4533
2,804	E4541
1,558	E4542
1,364	E4543
-250	E5111
-689	E5112
-640	E5113
24	E5121
-619	E5122
-546	E5123
-508	E5131
-1,057	E5132
-996	E5133
-673	E5211
-922	E5212
-894	E5213
-596	E5221
-969	E5222
-927	E5223
-899	E5231
-1,272	E5232
-1,230	E5233
-674	E5241
-985	E5242
-950	E5243
1,580	E5311
654	E5313
3,776	E5321
1,692	E5322
1,923	E5323
4,366	E5331
1,935	E5332
2,205	E5333
-669	E5411
-919	E5412
-892	E5413
-868	E5421
-1,118	E5422
-1,090	E5423
-1,171	E5431
-1,421	E5432
-1,393	E5433
-808	E5441
-1,058	E5442
-1,031	E5443
303	E5511
-274	E5512
-187	E5513
443	E5521
-235	E5522
-126	E5523
262	E5531
-537	E5532
-429	E5533
739	E5541
38	E5542
116	E5543
-1,142	K1--1
-3,253	K1--2
-2,404	K1--3
-3,719	K2--1
-7,575	K2--2
-8,706	K2--3
-9,133	K3--1
-19,172	K3--2
-21,695	K3--3
-22,436	K4--1
-45,573	K4--2
-61,991	K4--3
-68,081	K5--1
-132,582	K5--2
-179,336	K5--3

The next part of the report shows each variable with its lower and upper bounds. These values represent the fewest (left) and most (right) fishing days that could be assigned to the given E-variable. Bounds associated with each K-variable are the minimum (left) and maximum (right) number of boats that could participate in the fleet during this season.

```
..BOUNDS
  (83LOWER)
  (83UPPER)
     Lower & Upper Bounds

0 <= E1111    <=      7,200
0 <= E1112    <=     20,510
0 <= E1113    <=     15,158
0 <= E1211    <=      7,200
0 <= E1212    <=     20,510
0 <= E1213    <=     15,158
0 <= E1311    <=      7,200
0 <= E1313    <=     15,158
0 <= E1411    <=      7,200
0 <= E1412    <=     20,510
0 <= E1413    <=     15,158
0 <= E1511    <=      7,200
0 <= E1512    <=     20,510
0 <= E1513    <=     15,158
0 <= E2111    <=      1,373
0 <= E2112    <=      2,796
0 <= E2113    <=      3,213
0 <= E2121    <=      1,373
0 <= E2122    <=      2,796
0 <= E2123    <=      3,213
0 <= E2211    <=      1,373
0 <= E2212    <=      2,796
0 <= E2213    <=      3,213
0 <= E2221    <=      1,373
0 <= E2222    <=      2,796
0 <= E2223    <=      3,213
0 <= E2311    <=      1,373
0 <= E2313    <=      3,213
0 <= E2321    <=      1,373
0 <= E2322    <=      2,796
0 <= E2323    <=      3,213
0 <= E2411    <=      1,373
0 <= E2412    <=      2,796
0 <= E2413    <=      3,213
0 <= E2421    <=      1,373
0 <= E2422    <=      2,796
0 <= E2423    <=      3,213
0 <= E2511    <=      1,373
0 <= E2512    <=      2,796
0 <= E2513    <=      3,213
0 <= E2521    <=      1,373
0 <= E2522    <=      2,796
0 <= E2523    <=      3,213
0 <= E3111    <=      2,100
0 <= E3112    <=      4,408
0 <= E3113    <=      4,988
0 <= E3121    <=      2,100
0 <= E3122    <=      4,408
0 <= E3123    <=      4,988
0 <= E3131    <=      2,100
0 <= E3132    <=      4,408
0 <= E3133    <=      4,988
0 <= E3211    <=      2,100
0 <= E3212    <=      4,408
0 <= E3213    <=      4,988
0 <= E3221    <=      2,100
0 <= E3222    <=      4,408
0 <= E3223    <=      4,988
0 <= E3231    <=      2,100
0 <= E3232    <=      4,408
0 <= E3233    <=      4,988
0 <= E3241    <=      2,100
0 <= E3242    <=      4,408
0 <= E3243    <=      4,988
0 <= E3311    <=      2,100
0 <= E3313    <=      4,988
0 <= E3321    <=      2,100
0 <= E3322    <=      4,408
0 <= E3323    <=      4,988
0 <= E3331    <=      2,100
0 <= E3332    <=      4,408
0 <= E3333    <=      4,988
0 <= E3411    <=      2,100
0 <= E3412    <=      4,408
0 <= E3413    <=      4,988
0 <= E3421    <=      2,100
0 <= E3422    <=      4,408
```

0 <= E3423	<=	4,988	0 <= E4422	<=	2,014
0 <= E3431	<=	2,100	0 <= E4423	<=	2,739
0 <= E3432	<=	4,408	0 <= E4431	<=	991
0 <= E3433	<=	4,988	0 <= E4432	<=	2,014
0 <= E3441	<=	2,100	0 <= E4433	<=	2,739
0 <= E3442	<=	4,408	0 <= E4441	<=	991
0 <= E3443	<=	4,988	0 <= E4442	<=	2,014
0 <= E3511	<=	2,100	0 <= E4443	<=	2,739
0 <= E3512	<=	4,408	0 <= E4511	<=	991
0 <= E3513	<=	4,988	0 <= E4512	<=	2,014
0 <= E3521	<=	2,100	0 <= E4513	<=	2,739
0 <= E3522	<=	4,408	0 <= E4521	<=	991
0 <= E3523	<=	4,988	0 <= E4522	<=	2,014
0 <= E3531	<=	2,100	0 <= E4523	<=	2,739
0 <= E3532	<=	4,408	0 <= E4531	<=	991
0 <= E3533	<=	4,988	0 <= E4532	<=	2,014
0 <= E3541	<=	2,100	0 <= E4533	<=	2,739
0 <= E3542	<=	4,408	0 <= E4541	<=	991
0 <= E3543	<=	4,988	0 <= E4542	<=	2,014
0 <= E4111	<=	991	0 <= E4543	<=	2,739
0 <= E4112	<=	2,014	0 <= E5111	<=	244
0 <= E4113	<=	2,739	0 <= E5112	<=	476
0 <= E4121	<=	991	0 <= E5113	<=	644
0 <= E4122	<=	2,014	0 <= E5121	<=	244
0 <= E4123	<=	2,739	0 <= E5122	<=	476
0 <= E4131	<=	991	0 <= E5123	<=	644
0 <= E4132	<=	2,014	0 <= E5131	<=	244
0 <= E4133	<=	2,739	0 <= E5132	<=	476
0 <= E4211	<=	991	0 <= E5133	<=	644
0 <= E4212	<=	2,014	0 <= E5211	<=	244
0 <= E4213	<=	2,739	0 <= E5212	<=	476
0 <= E4221	<=	991	0 <= E5213	<=	644
0 <= E4222	<=	2,014	0 <= E5221	<=	244
0 <= E4223	<=	2,739	0 <= E5222	<=	476
0 <= E4231	<=	991	0 <= E5223	<=	644
0 <= E4232	<=	2,014	0 <= E5231	<=	244
0 <= E4233	<=	2,739	0 <= E5232	<=	476
0 <= E4241	<=	991	0 <= E5233	<=	644
0 <= E4242	<=	2,014	0 <= E5241	<=	244
0 <= E4243	<=	2,739	0 <= E5242	<=	476
0 <= E4311	<=	991	0 <= E5243	<=	644
0 <= E4313	<=	2,739	0 <= E5311	<=	244
0 <= E4321	<=	991	0 <= E5313	<=	644
0 <= E4322	<=	2,014	0 <= E5321	<=	244
0 <= E4323	<=	2,739	0 <= E5322	<=	476
0 <= E4331	<=	991	0 <= E5323	<=	644
0 <= E4332	<=	2,014	0 <= E5331	<=	244
0 <= E4333	<=	2,739	0 <= E5332	<=	476
0 <= E4411	<=	991	0 <= E5333	<=	644
0 <= E4412	<=	2,014	0 <= E5411	<=	244
0 <= E4413	<=	2,739	0 <= E5412	<=	476
0 <= E4421	<=	991	0 <= E5413	<=	644

```
  0 <= E5421    <=          244     150 <= K1--1    <=          300
  0 <= E5422    <=          476     150 <= K1--2    <=          300
  0 <= E5423    <=          644     150 <= K1--3    <=          300
  0 <= E5431    <=          244      25 <= K2--1    <=           50
  0 <= E5432    <=          476      25 <= K2--2    <=           50
  0 <= E5433    <=          644      25 <= K2--3    <=           50
  0 <= E5441    <=          244      38 <= K3--1    <=           75
  0 <= E5442    <=          476      38 <= K3--2    <=           75
  0 <= E5443    <=          644      38 <= K3--3    <=           75
  0 <= E5511    <=          244      10 <= K4--1    <=           20
  0 <= E5512    <=          476      10 <= K4--2    <=           20
  0 <= E5513    <=          644      10 <= K4--3    <=           20
  0 <= E5521    <=          244       3 <= K5--1    <=            5
  0 <= E5522    <=          476       3 <= K5--2    <=            5
  0 <= E5523    <=          644       3 <= K5--3    <=            5
  0 <= E5531    <=          244
  0 <= E5532    <=          476
  0 <= E5533    <=          644
  0 <= E5541    <=          244
  0 <= E5542    <=          476
  0 <= E5543    <=          644
```

The following section groups the variables affected by each species poundage limit (Q constraints) together with the maximum annual poundage available for the given species in that area. The number preceding each E-variable is the catch rate (q) for that fishing situation.

```
.CONSTRAINTS
  (83CONSTRAINT)
 Row: Q-11-     Elements:  15          Row: Q-12-     Elements:  12
             48 E1111                              106 E2121
             75 E1112                              158 E2122
             45 E1113                               79 E2123
             70 E2111                            1,091 E3121
            106 E2112                            1,364 E3122
             53 E2113                              927 E3123
            727 E3111                              851 E4121
            909 E3112                            1,064 E4122
            618 E3113                              723 E4123
            567 E4111                              818 E5121
            709 E4112                              900 E5122
            482 E4113                          737 E5123 <= 126,000
            546 E5111
            600 E5112
            491 E5113 <= 627,000
```

```
Row: Q-13-    Elements:   9       886 E4132
           909 E3131              603 E4133
         1,136 E3132              682 E5131
           773 E3133              750 E5132
           709 E4131              614 E5133 <= 474,000
```

```
Row: Q-1--    Elements:  36       567 E4111
            48 E1111              709 E4112
            75 E1112              482 E4113
            45 E1113              851 E4121
            70 E2111            1,064 E4122
           106 E2112              723 E4123
            53 E2113              709 E4131
           106 E2121              886 E4132
           158 E2122              603 E4133
            79 E2123              546 E5111
           727 E3111              600 E5112
           909 E3112              491 E5113
           618 E3113              818 E5121
         1,091 E3121              900 E5122
         1,364 E3122              737 E5123
           927 E3123              682 E5131
           909 E3131              750 E5132
         1,136 E3132              614 E5133 <=1,227,000
           773 E3133
```

```
Row: Q-21- Elements: 15    Row: Q-22-    Elements:  12
            40 E1211                      97 E2221
            63 E1212                     146 E2222
            38 E1213                      73 E2223
            65 E2211                     818 E3221
            97 E2212                   1,023 E3222
            49 E2213                     696 E3223
           546 E3211                     818 E4221
           682 E3212                   1,023 E4222
           464 E3213                     696 E4223
           546 E4211                     818 E5221
           682 E4212                     900 E5222
           464 E4213                   737 E5223 <= 4,687,500
           546 E5211
           600 E5212
       491 E5213 <=4,687,500
```

```
Row: Q-23-    Elements:   9
          818 E3231
        1,023 E3232
          696 E3233
          818 E4231
        1,023 E4232
          696 E4233
          818 E5231
          900 E5232
      737 E5233 <= 4,687,500
```

```
Row: Q-24-    Elements:   9
          682 E3241
          853 E3242
          580 E3243
          682 E4241
          853 E4242
          580 E4243
          682 E5241
          750 E5242
      614 E5243 <= 7,500,000
```

```
Row: Q-2--    Elements:  45
           40 E1211
           63 E1212
           38 E1213
           65 E2211
           97 E2212
           49 E2213
           97 E2221
          146 E2222
           73 E2223
          546 E3211
          682 E3212
          464 E3213
          818 E3221
        1,023 E3222
          696 E3223
          818 E3231
        1,023 E3232
          696 E3233
          682 E3241
          853 E3242
          580 E3243
          546 E4211
          682 E4212
          464 E4213
          818 E4221
        1,023 E4222
          696 E4223
          818 E4231
        1,023 E4232
          696 E4233
          682 E4241
          853 E4242
          580 E4243
          546 E5211
          600 E5212
          491 E5213
          818 E5221
          900 E5222
          737 E5223
          818 E5231
          900 E5232
          737 E5233
          682 E5241
          750 E5242
      614 E5243 <= 7,500,000
```

```
Row: Q-31-    Elements:  10
           20 E1311
           19 E1313
           34 E2311
           25 E2313
          231 E3311
          196 E3313
          425 E4311
          361 E4313
          711 E5311
      640 E5313 <= 12,500
```

```
Row: Q-32-    Elements:  12
          67 E2321
         101 E2322
          50 E2323
         462 E3321
         578 E3322
         393 E3323
         850 E4321
       1,062 E4322
         722 E4323
       1,422 E5321
       1,564 E5322
   1,280 E5323 <= 656,250
```

```
Row: Q-33-    Elements:   9
         539 E3331
         674 E3332
         458 E3333
         991 E4331
       1,239 E4332
         843 E4333
       1,659 E5331
       1,825 E5332
   1,493 E5333 <= 1,218,750
```

```
Row: Q-3--    Elements:  31
          20 E1311
          19 E1313
          34 E2311
          25 E2313
          67 E2321
         101 E2322
          50 E2323
         231 E3311
         196 E3313
         462 E3321
         578 E3322
         393 E3323
         539 E3331
         674 E3332
         458 E3333
         425 E4311
         361 E4313
         850 E4321
       1,062 E4322
         722 E4323
         991 E4331
       1,239 E4332
         843 E4333
         711 E5311
         640 E5313
       1,422 E5321
       1,564 E5322
       1,280 E5323
       1,659 E5331
       1,825 E5332
       1,493 E5333 <= 1,500,000
```

```
Row: Q-41-    Elements:  15
          40 E1411
          63 E1412
          38 E1413
         100 E2411
         150 E2412
          75 E2413
         500 E3411
         625 E3412
         425 E3413
       1,500 E4411
       1,875 E4412
       1,275 E4413
         750 E5411
         825 E5412
   675 E5413 <= 15,000,000
```

```
Row: Q-42-    Elements:  12
         100 E2421
         150 E2422
          75 E2423
         500 E3421
         625 E3422
         425 E3423
       1,500 E4421
       1,875 E4422
       1,275 E4423
         750 E5421
         825 E5422
     675 E5423 <= 15,000,000
```

```
Row: Q-43-    Elements:   9
          500 E3431
          625 E3432
          425 E3433
        1,500 E4431
        1,875 E4432
        1,275 E4433
          750 E5431
          825 E5432
      675 E5433 <= 15,000,000

Row: Q-44-    Elements:   9
          500 E3441
          625 E3442
          425 E3443
        1,500 E4441
        1,875 E4442
        1,275 E4443
          750 E5441
          825 E5442
      675 E5443 <= 15,000,000

Row: Q-4--    Elements:  45
           40 E1411
           63 E1412
           38 E1413
          100 E2411
          150 E2412
           75 E2413
          100 E2421
          150 E2422
           75 E2423
          500 E3411
          625 E3412
          425 E3413
          500 E3421
          625 E3422
          425 E3423
          500 E3431
          625 E3432
          425 E3433
          500 E3441
          625 E3442
          425 E3443
        1,500 E4411
        1,875 E4412
        1,275 E4413
        1,500 E4421
        1,875 E4422
        1,275 E4423
        1,500 E4431
        1,875 E4432
        1,275 E4433
        1,500 E4441
        1,875 E4442
        1,275 E4443
          750 E5411
          825 E5412
          675 E5413
          750 E5421
          825 E5422
          675 E5423
          750 E5431
          825 E5432
          675 E5433
          750 E5441
          825 E5442
      675 E5443 <= 15,000,000

Row: Q-51-    Elements:  15
          144 E1511
          225 E1512
          135 E1513
          272 E2511
          408 E2512
          204 E2513
          546 E3511
          682 E3512
          464 E3513
        1,091 E4511
        1,364 E4512
          928 E4513
        1,091 E5511
        1,200 E5512
    982 E5513 <= 15,000,000

Row: Q-52-    Elements:  12
          340 E2521
          510 E2522
          255 E2523
          682 E3521
          853 E3522
          580 E3523
        1,364 E4521
        1,705 E4522
        1,159 E4523
        1,364 E5521
        1,500 E5522
    1,228 E5523 <= 15,000,000
```

```
Row: Q-53-    Elements:   9
          682 E3531
          853 E3532
          580 E3533
        1,364 E4531
        1,705 E4532
        1,159 E4533
        1,364 E5531
        1,500 E5532
  1,228 E5533 <= 15,000,000
```

```
Row: Q-54-    Elements:   9
          818 E3541
        1,023 E3542
          696 E3543
        1,637 E4541
        2,046 E4542
        1,391 E4543
        1,637 E5541
        1,800 E5542
  1,473 E5543 <= 15,000,000
```

```
Row: Q-5--    Elements:  45
          144 E1511
          225 E1512
          135 E1513
          272 E2511
          408 E2512
          204 E2513
          340 E2521
          510 E2522
          255 E2523
          546 E3511
          682 E3512
          464 E3513
          682 E3521
          853 E3522
          580 E3523
          682 E3531
          853 E3532
          580 E3533
          818 E3541
        1,023 E3542
          696 E3543
        1,091 E4511
        1,364 E4512
          928 E4513
        1,364 E4521
        1,705 E4522
        1,159 E4523
        1,364 E4531
        1,705 E4532
        1,159 E4533
        1,637 E4541
        2,046 E4542
        1,391 E4543
        1,091 E5511
        1,200 E5512
          982 E5513
        1,364 E5521
        1,500 E5522
        1,228 E5523
        1,364 E5531
        1,500 E5532
        1,228 E5533
        1,637 E5541
        1,800 E5542
  1,473 E5543 <= 15,000,000
```

The E constraints section groups the E-variables affected by the maximum number of fishing days available for a fleet type in a given season. Each E-variable counts as one unit toward the total elements in the grouping. The negative value to the left of the K-variable indicates available fishing days NOT used yet. Zero, to the right of the relational sign, represents the upper limit value when all fishing days have been allocated.

```
Row: E1--1    Elements:   6
          1 E1111
          1 E1211
          1 E1311
          1 E1411
          1 E1511
        -24 K1--1 <=    0
```

```
Row: E1--2    Elements:   5
          1 E1112
          1 E1212
          1 E1412
          1 E1512
        -68 K1--2 <=    0
```

```
Row: E1--3    Elements:   6
          1 E1113
          1 E1213
          1 E1313
          1 E1413
          1 E1513
        -51 K1--3 <= 0
```

```
Row: E2--1    Elements:  11
          1 E2111
          1 E2121
          1 E2211
          1 E2221
          1 E2311
          1 E2321
          1 E2411
          1 E2421
          1 E2511
          1 E2521
        -27 K2--1 <= 0
```

```
Row: E2--2    Elements:  10
          1 E2112
          1 E2122
          1 E2212
          1 E2222
          1 E2322
          1 E2412
          1 E2422
          1 E2512
          1 E2522
        -56 K2--2 <= 0
```

```
Row: E2--3    Elements:  11
          1 E2113
          1 E2123
          1 E2213
          1 E2223
          1 E2313
          1 E2323
          1 E2413
          1 E2423
          1 E2513
          1 E2523
        -64 K2--3 <= 0
```

```
Row: E3--1     Elements:  19
                   1 E3111
                   1 E3121
                   1 E3131
                   1 E3211
                   1 E3221
                   1 E3231
                   1 E3241
                   1 E3311
                   1 E3321
                   1 E3331
                   1 E3411
                   1 E3421
                   1 E3431
                   1 E3441
                   1 E3511
                   1 E3521
                   1 E3531
                   1 E3541
                 -28 K3--1 <= 0
```

```
Row: E3--2     Elements:  18
                   1 E3112
                   1 E3122
                   1 E3132
                   1 E3212
                   1 E3222
                   1 E3232
                   1 E3242
                   1 E3322
                   1 E3332
                   1 E3412
                   1 E3422
                   1 E3432
                   1 E3442
                   1 E3512
                   1 E3522
                   1 E3532
                   1 E3542
                 -59 K3--2 <= 0
```

```
Row: E3--3     Elements:  19
                   1 E3113
                   1 E3123
                   1 E3133
                   1 E3213
                   1 E3223
                   1 E3233
                   1 E3243
                   1 E3313
                   1 E3323
                   1 E3333
                   1 E3413
                   1 E3423
                   1 E3433
                   1 E3443
                   1 E3513
                   1 E3523
                   1 E3533
                   1 E3543
                 -67 K3--3 <= 0
```

```
Row: E4--1     Elements:  19
                   1 E4111
                   1 E4121
                   1 E4131
                   1 E4211
                   1 E4221
                   1 E4231
                   1 E4241
                   1 E4311
                   1 E4321
                   1 E4331
                   1 E4411
                   1 E4421
                   1 E4431
                   1 E4441
                   1 E4511
                   1 E4521
                   1 E4531
                   1 E4541
                 -50 K4--1 <= 0
```

```
Row: E4--2     Elements:  18
                  1 E4112
                  1 E4122
                  1 E4132
                  1 E4212
                  1 E4222
                  1 E4232
                  1 E4242
                  1 E4322
                  1 E4332
                  1 E4412
                  1 E4422
                  1 E4432
                  1 E4442
                  1 E4512
                  1 E4522
                  1 E4532
                  1 E4542
               -101 K4--2 <= 0
```

```
Row: E4--3     Elements:  19
                  1 E4113
                  1 E4123
                  1 E4133
                  1 E4213
                  1 E4223
                  1 E4233
                  1 E4243
                  1 E4313
                  1 E4323
                  1 E4333
                  1 E4413
                  1 E4423
                  1 E4433
                  1 E4443
                  1 E4513
                  1 E4523
                  1 E4533
                  1 E4543
               -137 K4--3 <= 0
```

```
Row: E5--1     Elements:  19
                  1 E5111
                  1 E5121
                  1 E5131
                  1 E5211
                  1 E5221
                  1 E5231
                  1 E5241
                  1 E5311
                  1 E5321
                  1 E5331
                  1 E5411
                  1 E5421
                  1 E5431
                  1 E5441
                  1 E5511
                  1 E5521
                  1 E5531
                  1 E5541
               -49 K5--1 <= 0
```

```
Row: E5--2     Elements:  18
                  1 E5112
                  1 E5122
                  1 E5132
                  1 E5212
                  1 E5222
                  1 E5232
                  1 E5242
                  1 E5322
                  1 E5332
                  1 E5412
                  1 E5422
                  1 E5432
                  1 E5442
                  1 E5512
                  1 E5522
                  1 E5532
                  1 E5542
               -95 K5--2 <= 0
```

```
 Row: E5--3     Elements:  19                1 E5333
                    1 E5113                1 E5413
                    1 E5123                1 E5423
                    1 E5133                1 E5433
                    1 E5213                1 E5443
                    1 E5223                1 E5513
                    1 E5233                1 E5523
                    1 E5243                1 E5533
                    1 E5313                1 E5543
                    1 E5323             -129 K5--3 <= 0
```

The next part of the report presents program statistics and a statement as to whether this model's problem has a unique solution or whether there are possible alternatives. Alternative solutions mean that other fishing day allocations may produce the same fleetwide profit.

```
..ACTIVITY
  (83VA)
  (83CA)
..REDUCEDCOS
  (83VR)
  (83CR)

Statistics-
  LP83 Version 5.00
  Machine memory:  640K bytes.
  Pagable memory:  402K bytes.
  Variables:       217
  Constraints:      38
    38 LE,   0 EQ,   0 GE.
  Non-zero LP elements:     621
  Disk Space:     0K bytes.
  Page Space:    65K bytes.
  Capacity: 23.3% used.
  Estimated Time: 00:05:54

Iter   41
Solution Time:  00:00:05
*May have* Alternate Solution
```

The following table begins with the maximized goal. It represents the maximum fleetwide profit (in dollars) that could be earned if each fishing situation (E-variable) used all of the fishing days (under Activities) allocated to it by the LP83 program. The marginal net revenue per E-variable is given under Cost.

SOLUTION (Maximized): 10,841,266 HAWAII COMMERCIAL MULTIFISHERY LP MODEL - V1

	Variable	Activity	Cost		Variable	Activity	Cost
I	E1111	0	79	I	E1112	8,360	47
	E1113	0	23		E1211	0	1
	E1212	0	-21		E1213	0	-37
	E1311	0	6		E1313	0	-33
	E1411	0	-36		E1412	0	-50
	E1413	0	-60		E1511	7,200	169
	E1512	0	117	I	E1513	7,579	79
	E2111	0	92		E2112	0	45
	E2113	0	-4		E2121	0	171
	E2122	0	100		E2123	0	29
	E2211	0	21		E2212	0	-14
	E2213	0	-63		E2221	0	64
I	E2222	1,398	20		E2223	0	-40
	E2311	0	12		E2313	0	-71
	E2321	0	106		E2322	0	51
	E2323	0	-6		E2411	0	-13
	E2412	0	-50		E2413	0	-88
	E2421	0	-40		E2422	0	-77
	E2423	0	-114		E2511	0	291
	E2512	0	194		E2513	0	97
I	E2521	1,373	373		E2522	0	251
	E2523	0	130		E3111	0	929
	E3112	0	412		E3113	0	331
I	E3121	116	1,545		E3122	0	769
	E3123	0	649		E3131	0	1,089
I	E3132	417	443		E3133	0	342
	E3211	0	135		E3212	0	-159
	E3213	0	-223		E3221	0	355
I	E3222	1,787	26		E3223	0	-48
	E3231	0	244		E3232	0	-161
	E3233	0	-258		E3241	0	231
	E3242	0	-83		E3243	0	-163
	E3311	0	214		E3313	0	-139
	E3321	0	806		E3322	0	307
	E3323	0	230		E3331	0	916
	E3332	0	334		E3333	0	244

SOLUTION (Maximized): 10,841,266 HAWAII COMMERCIAL MULTIFISHERY LP MODEL - V1

	Variable	Activity	Cost	Variable	Activity	Cost
	E3411	0	-107	E3412	0	-385
	E3413	0	-429	E3421	0	-245
	E3422	0	-523	E3423	0	-567
	E3431	0	-455	E3432	0	-733
	E3433	0	-777	E3441	0	-203
	E3442	0	-482	E3443	0	-525
	E3511	0	696	E3512	0	266
	E3513	0	200	E3521	0	910
	E3522	0	373	E3523	0	289
	E3531	0	799	E3532	0	261
	E3533	0	178 I	E3541	1,984	1,219
	E3542	0	574 I	E3543	2,494	473
	E4111	0	508	E4112	0	143
	E4113	0	86	E4121	0	919
	E4122	0	372	E4123	0	286
	E4131	0	561	E4132	0	104
	E4133	0	33	E4211	0	64
	E4212	0	-210	E4213	0	-259
	E4221	0	254	E4222	0	-69
	E4223	0	-142	E4231	0	139
	E4232	0	-249	E4233	0	-322
	E4241	0	144	E4242	0	-163
	E4243	0	-224	E4311	0	1,009
	E4313	0	370	E4321	0	2,409
	E4322	0	1,303	E4323	0	1,131
I	E4331	228	2,786	E4332	0	1,495
	E4333	0	1,294	E4411	0	532
	E4412	0	158	E4413	0	99
	E4421	0	456	E4422	0	82
	E4423	0	24	E4431	0	341
	E4432	0	-52	E4433	0	-143
	E4441	0	479	E4442	0	105
	E4443	0	47	E4511	0	1,750
	E4512	0	919	E4513	0	789
	E4521	0	2,228	E4522	0	1,189
	E4523	0	1,028	E4531	0	2,113

SOLUTION (Maximized): 10,841,266 HAWAII COMMERCIAL MULTIFISHERY LP MODEL - V1

	E4532	0	1,074		E4533	0	913
I	E4541	763	2,804	I	E4542	1,982	1,558
I	E4543	2,739	1,364		E5111	0	-250
	E5112	0	-689		E5113	0	-640
	E5121	0	24		E5122	0	-619
	E5123	0	-546		E5131	0	-508
	E5132	0	-1,057		E5133	0	-996
	E5211	0	-673		E5212	0	-922
	E5213	0	-894		E5221	0	-596
	E5222	0	-969		E5223	0	-927
	E5231	0	-899		E5232	0	-1,272
	E5233	0	-1,230		E5241	0	-674
	E5242	0	-985		E5243	0	-950
	E5311	0	1,580		E5313	0	654
	E5321	0	3,776	I	E5322	180	1,692
	E5323	0	1,923	I	E5331	244	4,366
I	E5332	58	1,935	I	E5333	322	2,205
	E5411	0	-669		E5412	0	-919
	E5413	0	-892		E5421	0	-868
	E5422	0	-1,118		E5423	0	-1,090
	E5431	0	-1,171		E5432	0	-1,421
	E5433	0	-1,393		E5441	0	-808
	E5442	0	-1,058		E5443	0	-1,031
	E5511	0	303		E5512	0	-274
	E5513	0	-187		E5521	0	443
	E5522	0	-235		E5523	0	-126
	E5531	0	262		E5532	0	-537
	E5533	0	-429		E5541	0	739
	E5542	0	38		E5543	0	116
	K1--1	300	-1,142		K1--2	150	-3,253
	K1--3	150	-2,404		K2--1	50	-3,719
	K2--2	25	-7,575		K2--3	25	-8,706
	K3--1	75	-9,133		K3--2	38	-19,172
	K3--3	38	-21,695		K4--1	20	-22,436
I	K4--2	20	-45,573		K4--3	20	-61,991
	K5--1	5	-68,081		K5--2	3	-132,582
	K5--3	3	-179,336				

The K-variables (above table) show the number of boats included in the solution for the fleet during the given season under the Activity column. The negative cost value associated with the K-variable is the annual fixed cost per boat in that fleet category.

The next table presents all of the problem's constraints. Each species by area (Q-##-) and fleet by season (E#--#) category is listed under the Constraint column. For the Q constraints, the activity column shows all of this species poundage that was caught in the designated area, while the right hand side (RHS) column contains the total pounds available (annual sustainable species per area limit). Activity column values for the E constraints are 0 if either all fishing days or none were used up. A negative number indicates some days remained. The RHS column represents the upper limit (0) when all available fishing days are allocated.

File: HCMULT1 1/18/90 11:00:52 Page 1-8
CONSTRAINTS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Constraint	Activity		RHS	Constraint	Activity		RHS
Q-11-	627,000	<	627,000	Q-12-	126,000	<	126,000
Q-13-	474,000	<	474,000	Q-1--	1,227,000	<	1,227,000
Q-21-	0	<	4,687,500	Q-22-	2,031,856	<	4,687,500
Q-23-	0	<	4,687,500	Q-24-	0	<	7,500,000
Q-2--	2,031,856	<	7,500,000	Q-31-	0	<	12,500
Q-32-	281,250	<	656,250	Q-33-	1,218,750	<	1,218,750
Q-3--	1,500,000	<	1,500,000	Q-41-	0	<	15,000,000
Q-42-	0	<	15,000,000	Q-43-	0	<	15,000,000
Q-44-	0	<	15,000,000	Q-4--	0	<	15,000,000
Q-51-	2,059,958	<	15,000,000	Q-52-	466,667	<	15,000,000
Q-53-	0	<	15,000,000	Q-54-	12,473,375	<	15,000,000
Q-5--	15,000,000	<	15,000,000	E1--1	0	<	0
E1--2	-1,895	<	0	E1--3	0	<	0
E2--1	0	<	0	E2--2	0	<	0
E2--3	-1,607	<	0	E3--1	0	<	0
E3--2	0	<	0	E3--3	0	<	0
E4--1	0	<	0	E4--2	0	<	0
E4--3	0	<	0	E5--1	0	<	0
E5--2	0	<	0	E5--3	0	<	0

Total Error: 0.00

A Cost Analysis table apppears next. Each E-variable is presented with its Upper and Lower stable cost ranges and reduced cost values. The "Upper" number is the marginal net revenue that would be needed by this fishing situation before a change in the current solution (allocation of fishing days) would take place. The number to the right of the E-variable is its current marginal net revenue. The "Lower" value represents the marginal net revenue to which this fishing situation could fall before causing a change in the current solution. Numbers associated with the K-variables indicate corresponding "Upper", current and "Lower" values for annual fixed costs per vessel.

File: HCMULT1 1/18/90 11:00:52 Page 1-10
COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	121	E1511	Upper	50	K1--1
E1111	79		E1112	47	
Lower	77	K1--1	Lower	32	E3112
Reduced Cost		0	Reduced Cost		0
Upper	34	<------	Upper	50	<------
E1113	23		E1211	1	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		11	Reduced Cost		49
Upper	0	<------	Upper	6	<------
E1212	-21		E1213	-37	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		21	Reduced Cost		44
Upper	67	<------	Upper	22	<------
E1311	6		E1313	-33	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		61	Reduced Cost		55
Upper	50	<------	Upper	0	<------
E1411	-36		E1412	-50	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		85	Reduced Cost		50
Upper	6	<------	Upper	UNBOUNDED	
E1413	-60		E1511	169	
Lower	UNBOUNDED		Lower	127	<------
Reduced Cost		66	Reduced Cost		-42
Upper	122	<------	Upper	121	K1--3
E1512	117		E1513	79	
Lower	UNBOUNDED		Lower	73	E1--3
Reduced Cost		5	Reduced Cost		0
Upper	233	<------	Upper	86	<------
E2111	92		E2112	45	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		141	Reduced Cost		41
Upper	33	<------	Upper	263	<------
E2113	-4		E2121	171	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		37	Reduced Cost		93
Upper	132	<------	Upper	56	<------
E2122	100		E2123	29	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		32	Reduced Cost		27

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	189	<------	Upper	20	<------
E2211	21		E2212	-14	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		168	Reduced Cost		34
Upper	0	<------	Upper	189	<------
E2213	-63		E2221	64	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		63	Reduced Cost		125
Upper	135	K2--2	Upper	0	<------
E2222	20		E2223	-40	
Lower	0	E2--2	Lower	UNBOUNDED	
Reduced Cost		0	Reduced Cost		40
Upper	218	<------	Upper	22	<------
E2311	12		E2313	-71	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		206	Reduced Cost		92
Upper	247	<------	Upper	107	<------
E2321	106		E2322	51	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		141	Reduced Cost		56
Upper	44	<------	Upper	189	<------
E2323	-6		E2411	-13	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		49	Reduced Cost		202
Upper	20	<------	Upper	0	<------
E2412	-50		E2413	-88	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		70	Reduced Cost		88
Upper	189	<------	Upper	20	<------
E2421	-40		E2422	-77	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		228	Reduced Cost		97
Upper	0	<------	Upper	336	<------
E2423	-114		E2511	291	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		114	Reduced Cost		45
Upper	240	<------	Upper	110	<------
E2512	194		E2513	97	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		46	Reduced Cost		13
Upper	UNBOUNDED		Upper	296	<------
E2521	373		E2522	251	
Lower	328	E2511	Lower	UNBOUNDED	
Reduced Cost		0	Reduced Cost		44
Upper	138	<------	Upper	1,228	<------
E2523	130		E3111	929	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		8	Reduced Cost		300
Upper	590	<------	Upper	482	<------
E3112	412		E3113	331	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		179	Reduced Cost		150
Upper	UNBOUNDED		Upper	986	<------
E3121	1,545		E3122	769	
Lower	1,425	E3123	Lower	UNBOUNDED	
Reduced Cost		0	Reduced Cost		217

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	751	<------	Upper	1,110	<------
E3123	649		E3131	1,089	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	102		Reduced Cost	21	
Upper	UNBOUNDED		Upper	381	<------
E3132	443		E3133	342	
Lower	416	E3131	Lower	UNBOUNDED	
Reduced Cost	0		Reduced Cost	39	
Upper	777	<------	Upper	26	<------
E3211	135		E3212	-159	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	641		Reduced Cost	185	
Upper	98	<------	Upper	777	<------
E3213	-223		E3221	355	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	321		Reduced Cost	421	
Upper	52	E3131	Upper	98	<------
E3222	26		E3223	-48	
Lower	21	E3542	Lower	UNBOUNDED	
Reduced Cost	0		Reduced Cost	146	
Upper	777	<------	Upper	26	<------
E3231	244		E3232	-161	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	533		Reduced Cost	187	
Upper	98	<------	Upper	777	<------
E3233	-258		E3241	231	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	356		Reduced Cost	546	
Upper	26	<------	Upper	98	<------
E3242	-83		E3243	-163	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	108		Reduced Cost	261	
Upper	976	<------	Upper	267	<------
E3311	214		E3313	-139	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	762		Reduced Cost	406	
Upper	1,176	<------	Upper	525	<------
E3321	806		E3322	307	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	370		Reduced Cost	217	
Upper	437	<------	Upper	1,247	<------
E3323	230		E3331	916	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	207		Reduced Cost	332	
Upper	614	<------	Upper	498	<------
E3332	334		E3333	244	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	280		Reduced Cost	254	
Upper	777	<------	Upper	26	<------
E3411	-107		E3412	-385	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	884		Reduced Cost	411	
Upper	98	<------	Upper	777	<------
E3413	-429		E3421	-245	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost	526		Reduced Cost	1,021	

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	26	<------	Upper	98	<------
E3422	-523		E3423	-567	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		549	Reduced Cost		664
Upper	777	<------	Upper	26	<------
E3431	-455		E3432	-733	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,231	Reduced Cost		759
Upper	98	<------	Upper	777	<------
E3433	-777		E3441	-203	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		874	Reduced Cost		980
Upper	26	<------	Upper	98	<------
E3442	-482		E3443	-525	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		507	Reduced Cost		623
Upper	1,071	<------	Upper	394	<------
E3511	696		E3512	266	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		375	Reduced Cost		128
Upper	348	<------	Upper	1,145	<------
E3513	200		E3521	910	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		149	Reduced Cost		235
Upper	486	<------	Upper	411	<------
E3522	373		E3523	289	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		114	Reduced Cost		122
Upper	1,145	<------	Upper	486	<------
E3531	799		E3532	261	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		346	Reduced Cost		225
Upper	411	<------	Upper	1,339	E3123
E3533	178		E3541	1,219	
Lower	UNBOUNDED		Lower	1,198	E3131
Reduced Cost		233	Reduced Cost		0
Upper	578	<------	Upper	702	K3--3
E3542	574		E3543	473	
Lower	UNBOUNDED		Lower	434	E3133
Reduced Cost		5	Reduced Cost		0
Upper	2,272	<------	Upper	893	<------
E4111	508		E4112	143	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,764	Reduced Cost		750
Upper	912	<------	Upper	2,519	<------
E4113	86		E4121	919	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		826	Reduced Cost		1,600
Upper	1,202	<------	Upper	1,122	<------
E4122	372		E4123	286	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		830	Reduced Cost		836
Upper	2,180	<------	Upper	778	<------
E4131	561		E4132	104	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,619	Reduced Cost		674

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	834	<------	Upper	1,920	<------
E4133	33		E4211	64	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		801	Reduced Cost		1,856
Upper	453	<------	Upper	613	<------
E4212	-210		E4213	-259	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		663	Reduced Cost		871
Upper	1,920	<------	Upper	453	<------
E4221	254		E4222	-69	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,666	Reduced Cost		522
Upper	613	<------	Upper	1,920	<------
E4223	-142		E4231	139	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		755	Reduced Cost		1,781
Upper	453	<------	Upper	613	<------
E4232	-249		E4233	-322	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		702	Reduced Cost		934
Upper	1,920	<------	Upper	453	<------
E4241	144		E4242	-163	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,776	Reduced Cost		616
Upper	613	<------	Upper	2,287	<------
E4243	-224		E4311	1,009	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		836	Reduced Cost		1,278
Upper	925	<------	Upper	2,654	<------
E4313	370		E4321	2,409	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		554	Reduced Cost		245
Upper	1,370	<------	Upper	1,237	<------
E4322	1,303		E4323	1,131	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		68	Reduced Cost		106
Upper	2,843	Q-33-	Upper	1,535	<------
E4331	2,786		E4332	1,495	
Lower	2,754	E4332	Lower	UNBOUNDED	
Reduced Cost		0	Reduced Cost		40
Upper	1,349	<------	Upper	1,920	<------
E4333	1,294		E4411	532	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		55	Reduced Cost		1,388
Upper	453	<------	Upper	613	<------
E4412	158		E4413	99	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		295	Reduced Cost		513
Upper	1,920	<------	Upper	453	<------
E4421	456		E4422	82	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,464	Reduced Cost		371
Upper	613	<------	Upper	1,920	<------
E4423	24		E4431	341	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		589	Reduced Cost		1,579

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	453	<------	Upper	613	<------
E4432	-52		E4433	-143	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		504	Reduced Cost		755
Upper	1,920	<------	Upper	453	<------
E4441	479		E4442	105	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,441	Reduced Cost		348
Upper	613	<------	Upper	2,510	<------
E4443	47		E4511	1,750	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		566	Reduced Cost		760
Upper	1,190	<------	Upper	1,114	<------
E4512	919		E4513	789	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		271	Reduced Cost		324
Upper	2,657	<------	Upper	1,374	<------
E4521	2,228		E4522	1,189	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		429	Reduced Cost		185
Upper	1,239	<------	Upper	2,657	<------
E4523	1,028		E4531	2,113	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		211	Reduced Cost		544
Upper	1,374	<------	Upper	1,239	<------
E4532	1,074		E4533	913	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		300	Reduced Cost		327
Upper	2,837	E4332	Upper	1,611	E3131
E4541	2,804		E4542	1,558	
Lower	2,748	Q-33-	Lower	1,549	E3542
Reduced Cost		0	Reduced Cost		0
Upper	UNBOUNDED		Upper	3,255	<------
E4543	1,364		E5111	-250	
Lower	1,310	E4333	Lower	UNBOUNDED	
Reduced Cost		0	Reduced Cost		3,505
Upper	713	<------	Upper	1,205	<------
E5112	-689		E5113	-640	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,402	Reduced Cost		1,846
Upper	3,493	<------	Upper	975	<------
E5121	24		E5122	-619	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,469	Reduced Cost		1,594
Upper	1,419	<------	Upper	3,167	<------
E5123	-546		E5131	-508	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,965	Reduced Cost		3,674
Upper	616	<------	Upper	1,126	<------
E5132	-1,057		E5133	-996	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,672	Reduced Cost		2,121
Upper	2,916	<------	Upper	340	<------
E5211	-673		E5212	-922	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,590	Reduced Cost		1,262

COST ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Version 1

Variable	Stable Cost Range	Variable to Change	Variable	Stable Cost Range	Variable to Change
Upper	900	<------	Upper	2,916	<------
E5213	-894		E5221	-596	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,795	Reduced Cost		3,512
Upper	340	<------	Upper	900	<------
E5222	-969		E5223	-927	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,309	Reduced Cost		1,828
Upper	2,916	<------	Upper	340	<------
E5231	-899		E5232	-1,272	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,815	Reduced Cost		1,612
Upper	900	<------	Upper	2,916	<------
E5233	-1,230		E5241	-674	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		2,131	Reduced Cost		3,590
Upper	340	<------	Upper	900	<------
E5242	-985		E5243	-950	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,325	Reduced Cost		1,851
Upper	3,531	<------	Upper	1,453	<------
E5311	1,580		E5313	654	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,951	Reduced Cost		800
Upper	4,145	<------	Upper	1,707	Q-33-
E5321	3,776		E5322	1,692	
Lower	UNBOUNDED		Lower	1,592	E4322
Reduced Cost		369	Reduced Cost		0
Upper	2,006	<------	Upper	UNBOUNDED	
E5323	1,923		E5331	4,366	
Lower	UNBOUNDED		Lower	3,996	E5321
Reduced Cost		83	Reduced Cost		0
Upper	2,034	E4322	Upper	2,697	K5--3
E5332	1,935		E5333	2,205	
Lower	1,920	Q-33-	Lower	2,122	E5323
Reduced Cost		0	Reduced Cost		0
Upper	2,916	<------	Upper	340	<------
E5411	-669		E5412	-919	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,585	Reduced Cost		1,260
Upper	900	<------	Upper	2,916	<------
E5413	-892		E5421	-868	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,792	Reduced Cost		3,784
Upper	340	<------	Upper	900	<------
E5422	-1,118		E5423	-1,090	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,459	Reduced Cost		1,991
Upper	2,916	<------	Upper	340	<------
E5431	-1,171		E5432	-1,421	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		4,087	Reduced Cost		1,762
Upper	900	<------	Upper	2,916	<------
E5433	-1,393		E5441	-808	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		2,294	Reduced Cost		3,724

Variable	Stbl Cost Range	Var. to Change	Variable	Stbl Cost Range	Var. to Change
Upper	340	<------	Upper	900	<------
E5442	-1,058		E5443	-1,031	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,399	Reduced Cost		1,931
Upper	3,506	<------	Upper	989	<------
E5511	303		E5512	-274	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,203	Reduced Cost		1,263
Upper	1,431	<------	Upper	3,653	<------
E5513	-187		E5521	443	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,618	Reduced Cost		3,210
Upper	1,151	<------	Upper	1,564	<------
E5522	-235		E5523	-126	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,386	Reduced Cost		1,690
Upper	3,653	<------	Upper	1,151	<------
E5531	262		E5532	-537	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		3,392	Reduced Cost		1,689
Upper	1,564	<------	Upper	3,801	<------
E5533	-429		E5541	739	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,993	Reduced Cost		3,062
Upper	1,313	<------	Upper	1,696	<------
E5542	38		E5543	116	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		1,275	Reduced Cost		1,581
Upper	UNBOUNDED		Upper	0	<------
K1--1	-1,142		K1--2	-3,253	
Lower	-1,191	<------	Lower	UNBOUNDED	
Reduced Cost		-49	Reduced Cost		3,253
Upper	-311	<------	Upper	UNBOUNDED	
K1--3	-2,404		K2--1	-3,719	
Lower	UNBOUNDED		Lower	-5,184	<------
Reduced Cost		2,093	Reduced Cost		-1,465
Upper	-1,120	<------	Upper	0	<------
K2--2	-7,575		K2--3	-8,706	
Lower	UNBOUNDED		Lower	UNBOUNDED	
Reduced Cost		6,456	Reduced Cost		8,706
Upper	UNBOUNDED		Upper	-1,510	<------
K3--1	-9,133		K3--2	-19,172	
Lower	-21,744	<------	Lower	UNBOUNDED	
Reduced Cost		-12,611	Reduced Cost		17,662
Upper	-6,486	<------	Upper	UNBOUNDED	
K3--3	-21,695		K4--1	-22,436	
Lower	UNBOUNDED		Lower	-95,167	<------
Reduced Cost		15,208	Reduced Cost		-72,731
Upper	-40,248	E3131	Upper	UNBOUNDED	
K4--2	-45,573		K4--3	-61,991	
Lower	-46,524	E3542	Lower	-83,893	<------
Reduced Cost		0	Reduced Cost		-21,902
Upper	UNBOUNDED		Upper	-32,410	<------
K5--1	-68,081		K5--2	-132,582	
Lower	-142,573	<------	Lower	UNBOUNDED	
Reduced Cost		-74,491	Reduced Cost		100,172
Upper	-115,950	<------			
K5--3	-179,336				
Lower	UNBOUNDED				
Reduced Cost		63,386			

A marginal analysis is presented in the following table. Each resource that is fully utilized (thereby limiting the solution) is shown in a separate box. The Q constraints refer to the species poundage available per area, and the E constraints are maximum number of fishing days available to the stated fleet in that season. The value given for "increases objective by" is the amount (in dollars) that each unit of the limited resource contributed to the fleetwide profit.

MARGINAL ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Ver.1

Constraint at limit	Value	Constraint at limit	Value
Q-11- <	627,000	Q-12- <	126,000
Increases objective ... by	1	Increases objective ... by	1
Upper Limit.		Upper Limit.	
New limit ..	769,139	New limit ..	213,018
New optimum ...	10,929,571	New optimum ...	10,902,564
Forced to limit	E1--2	Forced to limit	K4--2
Lower Limit.		Lower Limit.	
New limit ..	0	New limit ..	0
New optimum ...	10,451,735	New optimum ...	10,752,507
Forced to limit	E1112	Forced to limit	E3121
Q-13- <	474,000	Q-33- <	1,218,750
Increases objective ... by	0	Increases objective ... by	0
Upper Limit.		Upper Limit.	
New limit ..	2,504,388	New limit ..	1,500,000
New optimum ...	11,586,337	New optimum ...	10,843,951
Forced to limit	E3222	Forced to limit	E5322
Lower Limit.		Lower Limit.	
New limit ..	0	New limit ..	1,127,695
New optimum ...	10,667,327	New optimum ...	10,840,397
Forced to limit	E3132	Forced to limit	E5332
Q-3-- <	1,500,000	Q-5-- <	15,000,000
Increases objective ... by	1	Increases objective ... by	1
Upper Limit.		Upper Limit.	
New limit ..	1,533,888	New limit ..	15,065,287
New optimum ...	10,870,546	New optimum ...	10,876,545
Forced to limit	K4--2	Forced to limit	K4--2
Lower Limit.		Lower Limit.	
New limit ..	1,306,046	New limit ..	13,005,359
New optimum ...	10,673,682	New optimum ...	9,763,430
Forced to limit	E4331	Forced to limit	K4--2
E1--1 <	0	E1--3 <	0
Increases objective ... by	50	Increases objective ... by	6
Upper Limit.		Upper Limit.	
New limit ..	13,062	New limit ..	7,579
New optimum ...	11,489,718	New optimum ...	10,887,945
Forced to limit	E1112	Forced to limit	E1513
Lower Limit.		Lower Limit.	
New limit ..	-2,961	New limit ..	-484
New optimum ...	10,694,263	New optimum ...	10,838,287
Forced to limit	E1--2	Forced to limit	K4--2

MARGINAL ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Ver. 1

Constraint at limit	Value	Constraint at limit	Value
E2--1 <	0	E2--2 <	0
Increases objective ... by	189	Increases objective ... by	20
Upper Limit.		Upper Limit.	
New limit ..	0	New limit ..	1,398
New optimum ...	10,841,266	New optimum ...	10,869,262
Forced to limit	E2521	Forced to limit	E2222
Lower Limit.		Lower Limit.	
New limit ..	-192	New limit ..	-1,398
New optimum ...	10,805,006	New optimum ...	10,813,270
Forced to limit	K4--2	Forced to limit	E2222
E3--1 <	0	E3--2 <	0
Increases objective ... by	777	Increases objective ... by	26
Upper Limit.		Upper Limit.	
New limit ..	116	New limit ..	2,596
New optimum ...	10,930,968	New optimum ...	10,907,963
Forced to limit	E3541	Forced to limit	Q-22-
Lower Limit.		Lower Limit.	
New limit ..	-80	New limit ..	-1,787
New optimum ...	10,779,316	New optimum ...	10,795,355
Forced to limit	K4--2	Forced to limit	E3222
E3--3 <	0	E4--1 <	0
Increases objective ... by	98	Increases objective ... by	1,920
Upper Limit.		Upper Limit.	
New limit ..	2,494	New limit ..	228
New optimum ...	11,084,508	New optimum ...	11,279,586
Forced to limit	E3543	Forced to limit	E4541
Lower Limit.		Lower Limit.	
New limit ..	-94	New limit ..	-40
New optimum ...	10,832,113	New optimum ...	10,764,682
Forced to limit	K4--2	Forced to limit	K4--2
E4--2 <	0	E4--3 <	0
Increases objective ... by	453	Increases objective ... by	613
Upper Limit.		Upper Limit.	
New limit ..	975	New limit ..	0
New optimum ...	11,282,553	New optimum ...	10,841,266
Forced to limit	K4--2	Forced to limit	E4543
Lower Limit.		Lower Limit.	
New limit ..	-32	New limit ..	-47
New optimum ...	10,826,822	New optimum ...	10,812,520
Forced to limit	K4--2	Forced to limit	K4--2
E5--1 <	0	E5--2 <	0
Increases objective ... by	2,916	Increases objective ... by	340
Upper Limit.		Upper Limit.	
New limit ..	0	New limit ..	124
New optimum ...	10,841,266	New optimum ...	10,883,476
Forced to limit	E5331	Forced to limit	E4331
Lower Limit.		Lower Limit.	
New limit ..	-24	New limit ..	-22
New optimum ...	10,771,768	New optimum ...	10,833,891
Forced to limit	K4--2	Forced to limit	K4--2

MARGINAL ANALYSIS: HAWAII COMMERCIAL MULTIFISHERY LP MODEL - Ver. 1

Constraint at limit	Value	Constraint at limit	Value
E5--3 <	0		
Increases objective ... by	900		
Upper Limit.			
New limit ..	152		
New optimum ...	10,977,718		
Forced to limit	E4331		
Lower Limit.			
New limit ..	-26		
New optimum ...	10,817,425		
Forced to limit	K4--2		

Updating Spreadsheet: C:HCMULT1.WKS(83VA)
Updating Spreadsheet: C:HCMULT1.WKS(83CA)
Updating Spreadsheet: C:HCMULT1.WKS(83CR)